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Editorial.

THE Editor and the Committee on Publications take occasion, at this time, to announce to the readers of the *Journal* certain changes, which it is their purpose to make in the conduct of this publication, and in which they hope for general co-operation and approval.

They propose, in the first place, to make every effort to secure such original matter, descriptive of important engineering works, as shall be of direct and evident value to practical engineers, preferring, in this respect, accurate and full descriptions of constructive details as actually executed, to theoretical discussions and mathematical investigations of general principles, which, however excellent of their kind, are of less direct interest to the working engineer, who is, as a rule, unable to bestow the time and attention necessary to eliminate an useful result from such studies. In pursuance of this plan, they have secured, and propose to publish in this and succeeding numbers, in addition to other matter of a similar kind, a very full description of the bridge, just finished, over the Susquehanna, at Havre de Grace, designed by George A. Parker, C. E., and constructed under his immediate supervision. This will be fully illustrated with elaborate working drawings, measurements, and every detail. In the second place, they propose to increase the proportion of original matter in the *Journal*, and to effect this, without detriment to the fund of

valuable information which has been heretofore reprinted from foreign magazines, by substituting carefully prepared abstracts of such articles as may be in this way faithfully rendered, for the entire papers as originally published, giving, in all cases, reference to the authority to which those desiring fuller information, may resort.

Again: they will offer every inducement to our mechanical constructors and inventors, by which they may be led to use the pages of this *Journal* as a means of publishing their inventions, and securing the attention of those most interested in such works. Lastly: for the promotion of that elementary knowledge on general scientific subjects, which is daily becoming more important to the successful prosecution of all arts, they propose to add to this *Journal* an Educational Department, in which the various sciences shall be, from time to time, treated in a simple, popular and practical manner, with very full illustration, and every attention to the earliest possible notice of all new facts and discoveries.

In the execution of the above-mentioned designs, the managers of this *Journal* confidently look for the co-operation of all who feel an interest in the advance of science and the arts in this country.

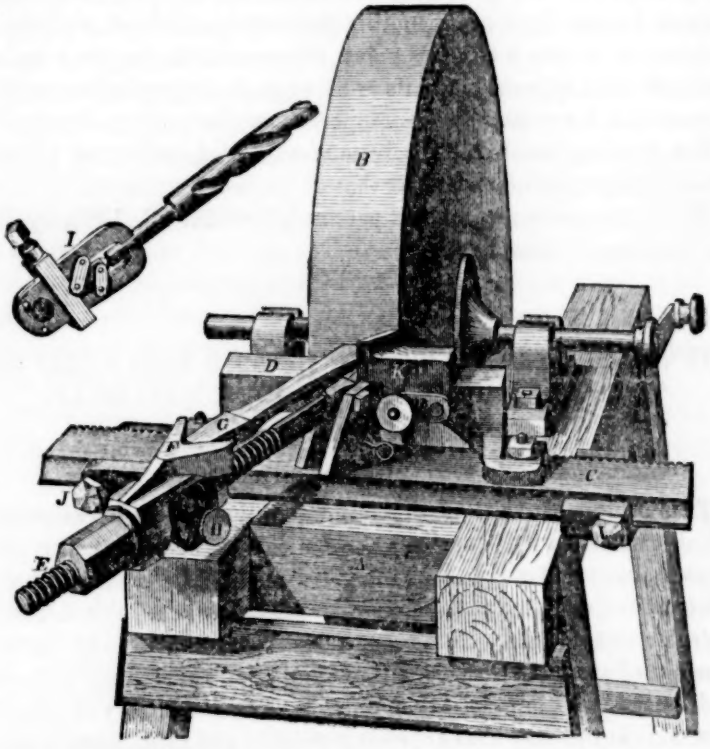
While in England and the Continent, Journals devoted to the interests of the civil and mechanical engineer, may be numbered by the tens, we might almost say hundreds, in this country, the *Journal of the Franklin Institute* stands alone. To it, must our engineers and machinists look for a just and impartial record of their works, which, circulated largely by reason of its exchanges throughout the world, may secure for them that extended reputation, which is the legitimate object of the most honorable ambition. By its means also, they may put on record, and thus preserve to future times and for the instruction of others, those experiences which otherwise perish with themselves, and leave the world but little benefited by their labors. To it they must look, again, for a medium by which a general exchange of ideas may be effected, and an opportunity offered for that free discussion so effective in the promotion of all progress and improvement.

In view of these and other like considerations, our engineers, manufacturers and machinists, should make common cause with us, and by aiding us, on the one hand, in obtaining early and full information on all topics in their departments and within their reach, and, on the other, by favoring the extended circulation of our publication, should strive to make this *Journal*, what we hope to see it, a creditable exponent and record of engineering, science and the mechanic arts in America.

Civil and Mechanical Engineering.

STRAHAN'S DRILL REST FOR GRINDING.

ALL of our readers who are interested in such matters, will be well aware of the difficulties which attend the grinding of a drill, in such a manner as to make both of its cutting edges exactly alike in angle and position, and of the necessity which exists for such equality.



Such grinding, difficult as it is with ordinary drills, becomes yet more so with twist-drills, which are now obtaining so large a popularity. It is, therefore, with great pleasure that we record the invention of the ingenious tool named above, by which all difficulty is avoided, an absolutely correct shape is secured, and the whole operation is reduced to the simplest form; so that no skill or experience is required for its successful execution.

The tool, as applied to the grindstone with the drill in its place, is shown in the accompanying cut.

To the frame of the grindstone, B, is attached the bed-plate, C, by means of the jaws, J J. This bed-plate carries a rest, D, with guide-block, K, to which is attached a pivoted screw, E, capable of vertical adjustment by means of a projection on its pivoted end, which is held in the position desired by a pin. This pivoted screw carries a sliding thrust-block, F, which is moved up by the nut shown at E.

The drill to be ground is supported on the rest, D, against the guide-block, K, with its heel in the thrust-block, F, and is gradually pressed forward by the nut, until sufficiently ground on one edge; a stopper, H, is then set at this point, the nut and thrust-block are run back, the drill is turned, and its other edge ground as before, until the thrust-block is arrested by the stopper, when the operation is complete.

For grinding twist-drills, a little vise is used, (shown at I,) whose centre always corresponds with that of its jaws.

The above arrangement was patented, October 2d, 1866, by Wm. H. Strahan, of Philadelphia.

THE SUSQUEHANNA BRIDGE ON THE PHILADELPHIA, WILMINGTON AND BALTIMORE RAILROAD.

Designed by George A. Parker, C. E.

PRELIMINARY NOTICE.

This bridge, of which a very full description will be hereafter published, commends itself to our attention chiefly, and beyond all other respects, by reason of the peculiar method employed in the erection of its substructure, and the special conditions which rendered this method so desirable and efficient. These conditions are now found to be repeated in many of our Western rivers, the bridging of which is one of the immediate problems in practical engineering, and the history of what has been done in this case thus acquires a peculiar and momentous interest.

A brief historical notice of this work and a general account of its prominent features may well preface the more detailed description of its structure, which we propose to develop.

As early as 1851, Mr. S. M. Felton, President of the Philadelphia, Wilmington and Baltimore Railroad, called upon the engineer of this bridge for his opinion on the subject of such a structure.

Some preliminary work was then executed, but financial difficulties led to the temporary abandonment of the enterprise.

In the summer of 1862, however, a more prosperous state of affairs warranted the resumption of the work.

The engineer was instructed to prepare plans for a structure, and to build one pier, which should be a test as to the practicability of the work. On the 15th day of September, of that year, the foundations of the third pier from the east bank of the river were commenced, and finished October 2d; that is, the foundation piles, numbering one hundred and fifty, were driven and sawed off to a uniform surface at a level of forty feet below the water.

The lateness of the season forbade continuing the work, and it was determined, therefore, to attempt the construction of the fourth pier, that pier being in shallow water, at a depth of about ten feet. The work of constructing it, it was thought, might be completed before the winter's floods. Operations were commenced October 15th. About one hundred foundation piles were driven and sawed off, ten feet under water, in four hours.

On the 28th of October the masonry of that pier was completed to the height of eight feet above low water. The following winter and spring were mild and subjected it to a less satisfactory test than was desired. Nevertheless, it was resolved to continue the work on the other piers, as the importance of the bridge became greatly enhanced owing to the existence of the Rebellion.

Accordingly, in the spring of 1863, pier No. 3 was examined by divers, and found to be covered by deposits of alluvium, varying from five feet to eighteen inches. By application of powerful pumps, aided by the skillful labors of divers, the deposit was removed in less than three days.

Additional piles were driven and sawed off by these divers at the level of the other piles, forty feet below the surface, and on the 24th of August the platform of timber and iron upon which the pier was to rest, was floated out over the site of foundation, and placed between two substantial construction-piers of timber.

Lowering screws, six in number, three and a half inches in diameter, were then attached to the platform and the construction-pier, and the first section of the boiler plate iron caisson, in which the masonry of the pier was to be built, was erected.

These screws were attached to the platform in such a way that they could be easily detached by the divers, after the platform was in place on the heads of the piles already mentioned (which had been sawed off forty feet under water), and worked through nuts which were attached to the construction-piers.

On the 24th of September of the same year, the masonry within the caisson was commenced, and the work went steadily on with the descent of the pier until two o'clock of the afternoon of November 9th, when suddenly one of the attachments of the screws to the platform gave way, the result of using imperfect material, and the pier careened to the west side of the pile inclosure.

The bottom of the platform was then within seven feet of the foundation-pile. The weight upon the screws was, perhaps, one hundred and forty tons. The caisson was still almost perfectly water-tight, and, supported as it was by the construction-piers, was entirely manageable.

Two courses of stone were immediately removed from the pier, the screws on the eastern side were turned off, and on the 11th of November the pier righted again, and at noon of the 15th it was finally landed upon the foundations. On December 18th, the masonry was completed to a height of about twelve feet above high water.

Some additional work was then done on pier 4, and work was commenced on the foundations of piers 5, 6 and 7. It was, however, soon discontinued for the season. In the following spring of 1864, work was recommenced on piers 5 and 6, and upon the foundations of pier 7. In April, the foundations of the eastern abutment were commenced, and during the year, the masonry was carried to the height of fourteen feet above low water.

During this year the greater part of the foundation of pier 1 was completed; pier 2 finished to the height of twelve feet above low water; pier 5 was entirely finished, and pier 6 was completed to the top of the coping. In the season of 1865 the eastern abutment was substantially completed, and piers 1 and 2 were nearly finished.

In the spring of this year it was found that the unusually severe freshet had made great changes about the foundation of pier 7. In several places fifteen feet of earth had been displaced, and it was deemed necessary to remove all the earth from the rock at that point, and to found the pier upon the rock bed, lying eighteen feet below the original bed of the river.

The work of removing this earth was one of great seeming difficulty. A wrought iron foundation caisson, averaging eight feet in height and about fifty by twenty feet square, was lowered so as to inclose the site of the pier. This was gradually depressed to the rock by removing the earth within it, by means mainly of powerful pumps, aided by the constant exertions of six skillful divers. The masonry was then laid within the tank, upon the solid rock, and brought to a level some feet below the top of the foundation caisson.

Upon that, the caisson of the pier resting upon the platform of timber, was lowered. This pier was completed on the 3d of December. Its foundation was thirty-six feet below low water. The foundations of pier 9 were commenced on the 2d of May, 1865, and finished September 27th. The masonry of that pier was completed October 23d; depth of water, thirty feet. Piers 12 and 13 were finished, and the masonry of the western abutment was brought to a safe height above low water, and before the 2d of that year three spans of the superstructure were erected.

In the present year, 1866, piers 7 and 8 were completed, and the foundation of pier 10, begun May 25th, was finished July 7th. Foundations of pier 11 were begun April 11th and finished June 19th. The western abutment was finished on the 15th of September. The guard and piers for the draw were commenced on the 9th of September, and are now nearly finished, thus completing the masonry connected with the bridge. July 25th, of this year, all but three of the thirteen spans of the superstructure were raised upon the piers, though not completed.

On that day a terrible tornado took place, which overthrew the whole superstructure then erected, except one span and the lower timbers of another. On the evening of that day, preparations were made for gathering together the wrecks of the prostrated bridge. On August 3d the rebuilding of the same was commenced, and on the 7th of November, *eighty-six working days from the time of commencement*, an engine passed over the two first spans.

On the 20th of November an engine passed entirely across the bridge. On this present day, November 26th, 1866, the bridge, though not entirely finished in all respects, is open to public travel. For five years from five hundred to one thousand men have been employed upon this great work. Upon its construction nearly five million feet of timber, twenty thousand cubic yards of masonry, three million pounds of wrought and cast iron have been used.

The structure between the shores of the river is about three thousand five hundred feet in length. It has thirteen supporting piers and two guard piers at the draw, and two abutments. The piers are built in water varying from ten to forty-five feet in depth. The spans are two hundred and fifty feet in length between bearings. The draw span is one hundred and seventy-six feet long. Height of superstructure twenty-five feet.

The superstructure is an improved form of the Howe truss. When completed each truss is to be encased entirely in iron, thus making it fire-proof and free from exposure to the weather. The peculiarity of the hydraulic engineering connected with this work is the disuse of the Coffer dam.

Instead thereof water-tight wrought iron caissons have been used.

The whole cost of the magnificent structure has been something less than $2,000,000.

The bridge is approached from the main road on the east side by a track laid over heavy trestle-work, fourteen hundred feet long. This trestle-work is but temporary, and, as soon as practicable, will be replaced by an earth embankment, supported by retaining walls of appropriate masonry. At the end of this is a firm abutment of strong masonry, handsomely constructed of granite from the quarries in the vicinity of Port Deposit, only six miles from the structure. This granite is of dark color, of elegant appearance when worked, and is said to be the hardest and heaviest in the world—heavier by three pounds to the cubic foot than that of the famous Egyptian Pyramids. There are one of these abutments in each end, similarly constructed.

The bridge is secured to the piers by means of bolts, three inches in diameter, which pass through holes drilled for that purpose to near the surface of the water, where they are, by means of a ring at the end, attached to a similar horizontal bar that passes through the sides of the pier. The upper ends of these perpendicular bars pass through a heavy oak bolster, and are fastened with a nut at the top, by means of the screw, upon which they can be tightened if occasion should require.

The timber of this structure has been very carefully selected. It has also gone through the process of Burnettizing, by which its durability is not only increased at least two-fold, but by which it is rendered indestructible by fire. This treatment was applied by Mr. Charles P. Bent, who has an establishment for the purpose at Perryville, and several others upon railroads in different States.

This process is familiar to our readers, and consists in removing air &c. from the fibres of the wood, by placing it in an exhausted vessel and then injecting chloride of zinc.

The timbers of the bridge are secured by means of iron bars and butt seats. These bars are about twenty-five feet long, and vary in thickness from one to three inches, the largest weighing seven hundred pounds. In the construction of the bridge nearly seventeen hundred of these bars are used. The immense weight of the structure may be estimated from the fact that there is used upon each span about two hundred tons of wood and iron. Iron is much more extensively used than is common in timber structures. As an instance, the bottom chords, where most exposed to a tensile strain, are entirely sheathed on the sides with plate iron three-eighths of an inch thick.

THE NEW YORK "CENTRAL PARK."

By WILLIAM H. GRANT, Superintending Engineer.

INTRODUCTORY REMARKS.

THE New York Central Park, now nearly completed, has grown up under steady and uninterrupted progress during the last few years—passing through a most eventful and trying period, financially and otherwise—into a great municipal work, that presents at this time to the liberal and enlightened citizens of New York, who have created it, its elevating and invigorating influences, with a promise of constantly expanding attractions and benefits, as nature, assisted by the hand of art, is permitted, in her own inimitable ways, to perfect the work that has thus far been accomplished. It is a new work of its kind in this country. In its design and execution it has developed and practically applied the combined problems of civil engineering and landscape gardening, on a larger scale, and in a much greater variety of forms, than has heretofore occurred among us. As a pioneer improvement of this character, taking the lead of, and directing the way for, a series of similar works that the advancing wave of intelligence and wealth is soon to spread widely over the country—it has a value that surpasses even its local worth (great as that is) to its fortunate possessors.

It is only about eight years since the first spade was put in the ground, the first drill driven in the rock, and the example has been followed by several neighboring cities, as Baltimore, Philadelphia, Brooklyn &c., in the laying out of public parks, some of which are well advanced; other parks are contemplated, not only by well-grown cities, but by thriving villages, cities in embryo. An impulse has also been given to individual as well as municipal enterprise, as evidenced in the rural improvements that are beginning to be made, on a liberal scale, by men of wealth, and by an increasing desire that is manifested by persons of more limited means for the tasteful adornment of their residences.

The Central Park has become the resort of those several classes of persons who seek here for examples and hints to serve their respective purposes. Some come to scan the design as a whole—to take in its entire scope—and form in their minds ideas as to its adaptation to some other locality of similar extent; some select a more limited space, and study its suggestions and special mode of treatment to meet their particular views; others give their attention to such separate classes of

work only as they may have occasion to reproduce; and others again seek only a single specialty, to learn from it how to supply a want of that kind. A wide and diversified field is presented for pursuing these investigations, and few fail to cull from it ideas that are available, to a greater or less extent, according to the taste and discernment they respectively possess; their views are enlarged and perceptions quickened upon a range of subjects of utility and beauty, and much good grows out of it. But, after all, it must be felt by each person in the pursuit of this kind of knowledge, in this way, that he labors under difficulties that it would be desirable to remove, an acquaintance with the principles upon which the whole, or any part, of the work is based, is wanted. A fair surface is presented to the eye, and all is agreeable and attractive, but the foundation of the structure is concealed, and without some knowledge of this—although a superficial copy may be made—the whole is liable to fail, and prove an unsubstantial and "baseless fabric of a vision."

In order to meet a want of this kind, and supply some practical aids to those who wish to apply judiciously both the principles and practice that have governed the execution of the work, is the object of the following pages.

It is scarcely necessary to premise further, that the work of the Park, from its novelty and the inexperience that prevailed at its commencement, has had to be studied out step by step in all its departments and details—from the outline plan of a portion of the work that was adopted as a basis to start from, down to its present nearly completed condition. It would have been of great service to all who have participated in the work if they could have referred directly to examples and data to meet the various cases as they arose, even the most trivial ones, and would have saved them the expenditure of much mental labor and anxiety.

When this is remembered, it is not doubted that the description of the practices and processes that is here given will prove of service to others who may have occasion to reproduce similar works. Some things may appear in the recital, simple, and even trite—they appear so *now* to the writer—but it has not been considered advisable to pass them by, in the general connection, on that account. Brevity has been studied as far as reasonable clearness would allow; and it has been the aim to mass together facts and matters of interest, rather than to make the subject what may be called, popularly readable. Upon these points and accuracy of description alone the writer expects to escape criticism. The circumstances under which these pages

have been put together have not been favorable to any other endeavor than this. If the substance should be found of practical value, the reader will leniently overlook the imperfections of form or medium through which it is presented. Should these desirable results occur, I might say, in customary phrase, that the object of the writer will be fully attained; this, however, would not be strictly correct, for I have had an additional incentive in the undertaking—that of contributing a testimonial to the Engineer Corps by whom I have been aided, and to whom a large share of the credit is due for the successful execution of the works of the Park. Few persons are aware of the unwearied vigilance, the close and exact attention and skill, that have been exercised by these gentlemen in the course of the long service these works have required. It is with great pleasure that I make this the occasion—I hope the reader will think not inappropriately—to render to them the best acknowledgment in my power, not only for their professional aid, but for their social companionship, through the several years' journey—not always over ground that was free from asperities—that we have made together.

It is not my province to speak in commendation of the Board of Commissioners, under whose administration this work has been carried forward; but in so far as they have permitted those to whom they have entrusted its execution, to conduct it, free from the absorbing and evil influences of politics, I cannot refrain from expressing my individual gratitude and admiration. In this respect, the Central Park has been exceptional to most of the public works that have been executed under our municipal or state authorities. Its continued success will be dependent, even in a greater degree than heretofore, upon the maintenance of the policy that has been thus wisely inaugurated. Personally, I should feel it a misfortune to see this costly and beautiful work thrown into the arena of politics. I should expect, in such an event, to see the works upon which months and years of study and care have been expended, neglected, misunderstood and perverted, a loose and disorderly management dispelling the feeling of security and quiet that is essential to the enjoyment of all visitors, and a rapid deterioration of the Park from all the objects for which it was designed. Such results every good citizen—every person, of whatever degree, to whom the privilege is extended, and it is extended to all, to enjoy this healthful pleasure ground—must deprecate. Difficult as it may be (and there are difficulties) to exclude political influences, it must nevertheless be done, not alone in appearances, covering over an insidious and deleterious under-current, invisible for the time to the public eye, but in

all honesty and fidelity. As a work of art, the first that has arisen among us of its kind, it is doubtless to be subjected to a severe test; its management is a serious experiment: if it goes wrong, it will be fatal; if right, the blessings of multitudes of pent-up men, women and children will attend it.

The class of works of the Park that the public have manifested the earliest interest in, and from which they have thus far realized the largest benefit, is that of *roads and walks;* these have preceded most other improvements in the order of construction, and will doubtless meet, in their practical application, if found adapted to the object, the largest range of public and individual every-day wants. They have consequently been selected as the first subject to occupy attention.

As the subject of landscape design would naturally be expected to take precedence of works of construction, it is proper to say that the design of the Park, as a whole, as now nearly worked out, was progressive, was the work of several different persons at different times, and was not completed much in advance of actual construction; and therefore is deferred to the close of other details. In that place it will be considered more comprehensively, in its origin, history, adaptation &c.

HEATING AND VENTILATION OF THE PHILADELPHIA ALMSHOUSE.

Extract from the Report of the Committee, JOHN M. WHITALL, Chairman.

THE VENTILATION.

WHEN your Committee was appointed, all parts of the Almshouse were imperfectly ventilated—the Hospital and Insane Departments by connections with a large chimney in each, but which we found nearly or quite useless for the purposes intended, and the alterations necessary to be made in removing the boilers from the building required the plan of ventilation to be entirely changed. In other departments there was no ventilation, excepting by the doors or windows, with the exception of an occasional fire-place in some of the wards. As the warm air was introduced into the different apartments by our improvements, an independent flue for ventilation was erected in each, extending through the roof, and thus the egress of foul air could not be interfered with by connection with other wards. This has been found to be a very important condition. In these, flues

in the Hospital, openings near the ceiling and near the floor, were made, with a register in each. In using them, it was soon discovered that if the floor openings were closed and the ceiling registers opened, the wards became foul and the temperature lower. On the contrary, by closing the apertures near the ceiling and opening the registers near the floor, the thermometer at once indicated increased warmth, and the wards were directly cleared of all offensive odor. This experiment having been fully tested, and always with the same result, the use of the upper ventilator was entirely dispensed with. In all other parts of the Almshouse the same general plan has been followed. In those wards which are heated by direct radiation from steam-pipes or stoves, openings near the floor have been made into flues, extending through the roof, so that the Nurseries, Out-wards &c. are at all times free from any unpleasant effluvium.

THE CHOLERA.

Your Committee beg leave to call your attention to the breaking out of cholera at the Almshouse in the present year, and to the apparent effect, under the blessing of a kind Providence, produced by thorough ventilation from the floor, in its prevention and final disappearance from the Institution. The disease first attacked four patients and a nurse in one of the wards of the Women's Hospital, which ward, upon close examination, was found to be imperfectly ventilated. This was at once remedied, after which there were no more cases in the Hospital.

In the Insane Department for females, the cholera occurred in several of the wards; these were ventilated by the old plan, from the ceiling or by windows and doors, as the ventilation in this Department was not yet perfected, but on the appearance of the disease strong efforts were immediately made to push it forward, and it is a remarkable fact, that as soon as a thorough ventilation from the floor was established, the cholera disappeared from the Institution. It may be proper here to remark, that heat was introduced into the wards about two hours, daily, during the prevalence of the disease, and it is also worthy of note that in no part of the Almshouse, although crowded, was there any cholera where the ventilation from the floor was thoroughly perfected. And we would further state, that since it has been fully established, no case of fever or dysentery, and very few of erysipelas or gangrene, have originated in the Hospital, or any part of the House. And those patients brought in from the city with these diseases, mostly soon recovered, and the health of the inmates is at this time excellent.

Your Committee believe that the ventilation of the Almshouse, in all the wards, is so perfect that rarely any hospital smell or offensive odor can be perceived in passing through. (See Secretary's Report.)

From the London Engineering, No. 44.

THE METROPOLITAN DISTRICT RAILWAY.

THE present Metropolitan Railway, extending from Bishop's Road to Moorgate Street, forms, as is very generally known, but the northern side of an irregular "circle" of underground railways which will surround that part of the metropolis lying between the existing line and the Thames. Of this "inner circle," as it is called, the Metropolitan District Railway will form the southern side, whilst the eastern and western portions will be formed by extensions of the Metropolitan Railway, acts for the construction of these additional lines, of which Mr. John Fowler and Mr. T. Marr Johnson are the joint engineers, having been obtained in 1864.

By examining the routes, both constructed and proposed, for the Metropolitan District and the Metropolitan Extension Railways, it will be seen that, at the eastern end, the extension of the Metropolitan Railway is to be carried under Bishopsgate Street, near Houndsditch, and that it will then curve to the south, extending, under Aldgate High Street and the Mineries, to Trinity Square. At Trinity Square the Metropolitan District Railway will commence, and from this point it will proceed nearly parallel to the river until it cuts the line of the new street which is to be constructed from Blackfriar's Bridge to the Mansion House. Following the line of this street, the railway will reach the river at Blackfriars, and will then be carried along the embankment to within a short distance of Westminster Bridge. At this point the line will leave the river side, and, curving to the west, will proceed past Westminster Abbey, under Tothill Street, and along the northern side of Victoria Street, to the Victoria Station. Beyond this station the railway will bend round to the south, and, after passing for a short distance between Ebury Street and Belgrave Place, it will again turn to the west to Sloane Square. From Sloane Square the line will follow an almost straight course to Cromwell Road, where it will join the western extension of the Metropolitan Railway. From Cromwell Road the western extension of the Metropolitan line will curve to the north, and will proceed in a north-westerly direction to Kensington Terrace, Notting Hill, where it will curve to the east, and eventually join the existing line at Edgeware Road.

The Metropolitan District Railway includes, beside the line of which we have described the course, two branch lines connecting the "inner circle" with the West London Railway. One of these branches will

commence at Cromwell Road station, and, after proceeding side by side with the "inner circle" line, to a short distance beyond the Gloucester Road, will turn to the south-west through Earl's Court to a junction with the West London line near Richmond Road. The other branch will leave the western side of the West London Railway, further north, and will then curve to the east, pass under the West London line, and run through Earl's Court, by the side of the branch first mentioned, to a short distance past Redfield Lane, where it will bend to the north, and will be carried side by side with the inner circle line to Kensington station.

The station accommodation which will be provided on the new lines will be as follows: On the eastern extension of the Metropolitan line there will be a station at Bishopsgate Street, and another near Aldgate, whilst at Trinity Square there will be a joint station for the extension of the District railways, this station forming an exchange station with the London and Blackwall Railway. On the Metropolitan District Railway proper there will be stations at Mark Lane, King William Street, and at Queen Street (Cannon Street); and at Blackfriars there will be an exchange station with the London, Chatham and Dover Railway. There will also be a station at Norfolk Street; and at Charing Cross there will be an exchange station with the South-Eastern line. The next station will be at Westminster Bridge, and then will come the St. James' Park and Victoria stations, the former of which will be situated close to Queen's Square Place, and the latter adjoining the present station of the same name, so that it will form an exchange station with the London, Chatham and Dover, and London, Brighton and South Coast Railways. The next stations in order will be those at Sloane Square and Cromwell Road, whilst there will also be stations, used jointly by the Metropolitan District and Metropolitan Railway proper, at Gloucester Road and Kensington, and another at Richmond road, for the joint use of the Metropolitan District and West London Railways. The Cromwell Road and Kensington stations will be exchange stations for the traffic to the West London Railway and its connections. On the western extension of the Metropolitan line there will be, in addition to the two joint stations already mentioned, other stations at Notting Hill, Bayswater and Paddington. The last station will be situated opposite the Paddington Hotel, and will be connected with the Great Western station by underground passages; it will be quite distinct from the existing Bishop's Road station.

The total length of the Metropolitan District Railway, from Tower Hill to the Richmond Road, is about six miles, and of this length one-half will be level. Of the remaining portion, about a quarter of a mile will be on a gradient of 1 in 300, more than half a mile will be 1 in 250, three-quarters of a mile 1 in 200, and about half a mile 1 in 100, whilst the rest will be made up of gradients rather less steep than 1 in 100. The greatest difference between the levels of the rails at any two points is 37¾ feet, and the three lowest points are under the Ranelagh, Fulham Road and King's Scholars' Pond sewers, respect-

ively, the rail-level of the latter point, which is the lowest of all, being 9 feet 3 inches below ordnance datum, or 21 feet 9 inches below Trinity high water. The sharpest curve is one of 10 chains radius near the Victoria station; the remaining curves have radii of 15, 20, and 30 chains and upwards.

Having given a general account of the course and extent of the Metropolitan District Railway, we shall now proceed to describe more in detail the principal works connected with it, so far as they are at present executed or in progress. Between Trinity Square and Westminster Bridge, the only portions which have been executed are two short lengths, one in front of the Cannon Street station of the South-Eastern Railway and the other under the London, Chatham and Dover Railway, at Blackfriars. The piece at Cannon Street is 225 feet in length, and is covered by wrought iron girders bent downwards at the ends, so that they have a shape resembling the outline of a Mansard roof. On these girders are erected brick walls, and between these are turned arches, upon which the superincumbent earth and road-metalling is carried. The object of this mode of construction was to lessen the thickness of earth &c. above the girders, and thus reduce, as far as possible, the load upon them.

At Westminster, the first length of the works in hand commences close to New Palace Yard, and extends to the eastern end of Victoria Street. For this length, the line will be carried in girder-covered way, the roofing being formed of cast iron girders, with intermediate brick arches. Under Parliament Square Gardens, the side walls are being constructed with 6 feet bays, measured from centre to centre of the counterforts; and the girders are 6 feet apart, and 1 foot 6 inches deep in the centre. Nearer Bridge Street, however, the walls are being made with 8 feet bays, the girders being 2 feet 6 inches deep in the centre, and this is the ordinary construction of girder-covered way along the line. The girders have top flanges 7 inches $\times 1\frac{3}{4}$ inch, and bottom flanges 20 inches by $2\frac{1}{4}$ inches, and the web is $2\frac{1}{4}$ inches thick at the top and 2 inches at the bottom, whilst the distance between the walls or span of the girders is 25 feet. The girders are furnished with cross flanges, projecting downwards 6 inches from the underside, which bear against the inner sides of the side walls and thus strut them apart. The brick arches between the girders are three rings thick, and the spandrils are filled in with concrete, over which is a layer of asphalte, $\frac{3}{4}$-inch thick, this being put on in two coats of $\frac{3}{8}$-inch each. Upon the asphalte there is laid under the streets 1 foot of road-metalling. The clear height of the undersides of the girders above rail-level is 13 feet 6 inches.

The counterforts of the side walls are 5 feet 6 inches deep horizontally for their whole height, being built without batter; whilst their thickness is three bricks in front of, and two bricks behind, the arched panels. The panels are formed of three rings of brickwork, and are built with a batter. The walls are founded on concrete carried 5 feet below rail-level, and the panels are also backed with concrete to the

level of the backs of the counterforts, each bay being provided with a 4-inch pipe packed around with gravel for the purposes of drainage. An 18-inch barrel-drain is also carried down the centre of the line at a variable distance below the rail-level, and from Blackfriar's Bridge to Gloucester Road the excavation will be provided with a concrete invert 2 feet 6 inches thick.

The manner in which the construction of the covered way is carried out is as follows: Two trenches are excavated at the proper distance apart to receive the side walls, and the space between them is, where necessary, lowered to make room for the girder covering. The sides of the trenches are, of course, supported by the usual struts and poling boards, and, as the construction of the side walls proceeds, these are removed and replaced by the concrete backing at the back of the walls and struts extending from the inner sides of the wall to the central "core" between the two trenches. These last-mentioned struts are allowed to remain until the brickwork has thoroughly set; and when the covered way is completed, the central core is removed by excavation from the ends. By proceeding in this manner, the only earth &c. which has to be lifted is that which is taken out of the trenches for the side walls, and this is raised by the aid of steam cranes traversing on temporary rails laid by the side of the excavations. At the portion of the line which we are now describing, the excavations are made almost entirely through sand and gravel, (the clay being, however, reached near the foundation level,) and by carrying out the system of end excavations of the central core, the material can be readily conveyed by trollies, running on temporary rails, to points on the line where it can be screened, and that portion not required for making mortar or concrete sold at a remunerative price. If, on the other hand, the excavation was completed at once, and the part forming the core raised before the covered way was finished, great expense would be incurred on account of there being but in few cases available storage room for the excavated material, and all that portion which could not be immediately disposed of would have to be carted away.

Where the excavation has to be carried under the line of a street, a very simple way of constructing a temporary bridge is in most cases adopted, the bridge being formed for half the width of the road at one time, so as to interrupt the traffic as little as possible. Longitudinal trenches, about 2 feet 6 inches deep, are first cut in the roadway, 4 feet apart, these trenches being sufficiently long to receive timber balks which will span the intended excavation. The surface of the ground between the trenches is then lowered, and cross planking placed upon the balks, and upon this planking is laid about 1 foot of road-metalling. After the whole of the temporary bridge has been constructed in this manner, the ground is excavated beneath, and the construction of the works proceeded with, as at other parts of the line. When gas or water-pipes are met with, which will eventually be supported by the roof of the covered way, they are sustained by slinging them from balks overhead, and also by struts extending to the

ground below, these struts being replaced by longer ones as the excavation goes on. Brick sewers which cross the line of the railway are also supported in a similar manner, until removed and replaced by iron structures. Near Parliament Square Gardens, the present Victoria Street sewer thus crosses the line of the works. In this case the sewer is to be diverted, and a length of the present brick sewer replaced by a new sewer carried along the southern side of the railway, at the back of the side wall, to the low-level sewer at the Thames embankment. Another similar sewer will also be formed along the northern side of the line for some distance, so as to intercept the sewers which now extend from that side to the Victoria Street sewer, this new sewer eventually joining the existing Victoria Street sewer at the point where it leaves the northern side of the railway.

Near the end of Victoria Street, the centre line of the railway passes about 95 feet from one of the corners of Westminster Abbey, and, for a length of 300 feet near this point, a retaining wall of extra strength is being built along the southern side of the line, which here runs nearly east and west. This wall, instead of being built in bays, is 5 feet 6 inches thick throughout, and is backed with peat for a thickness of 7 feet, this thickness of peat being, however, reduced at the bottom, where the sewer already mentioned is situated, the sewer being formed for this length of 300 feet of an iron pipe 4 feet 6 inches in diameter. This system of peat backing, has been adopted at the recommendation of Mr. G. P. Bidder, acting as engineer to the Dean and Chapter of Westminster, in order to prevent any vibration being transmitted from the railway to the Abbey. We may mention here that it has been sometimes stated that the Abbey was founded on a running sand, but in the excavations which have been made for the Metropolitan District Railway only good sound gravel has been met with.

Owing to possession not yet having been obtained of the intervening property, nothing has yet been done towards the construction of the line between Parliament Square Gardens and Buckingham Row, with the exception of some slight excavations in the neighborhood of the St. James' Park station. This station will, as we have already stated, be situated close to Queen's Square Place, and it will be provided with siding accommodation. Between the St. James' Park station and Buckingham Row the line will be carried partly through girder-covered way and partly through covered way roofed with brick arches. At Buckingham Row another long length of the works in progress commences, there being first a short length of brickwork-covered way, and then about 160 yards of open cutting succeeded by works which we shall describe presently.

The difference between the construction of the brickwork-covered way and a tunnel, is chiefly that, in making the latter, the excavation is driven from the ends, whereas in constructing the brickwork-covered way the ground is opened up to the surface and then filled in again upon the top of the arches. In the case of the Metropolitan

District Railway there is no tunnel properly so called at any part. In the ordinary brickwork-covered way the arches are composed of five rings of brickwork, and have a span of 25 feet, the clear height under the crown of the arch being 15 feet 9 inches above rail-level. The curve of the crown of the arch is struck with a radius of 15 feet 9 inches, and the haunches with radii of 9 feet 6 inches, whilst the side walls have a curved batter on the face, struck with a radius of 25 feet from a centre situated 5 feet 6 inches above rail-level. The side walls are three bricks thick at the springing of the arch, and the back is carried down perpendicularly to the foundations. At intervals of 50 feet there are formed in the side walls arched recesses or manholes, 4 feet wide, 1 foot 6 inches deep in the centre, and 7 feet high, the back of each recess being formed of a horizontal arch composed of three rings of brickwork, and having a versed sine of 9 inches. The haunches of the arched covering are filled in with concrete, the upper surface being sloped off towards each side and coated with asphalte ¾-inch thick, laid on in two layers. At the back of the side walls drain-pipes are led down to near the footings, and are then carried through the walls, and, in fact, their arrangement, as well as that of the central 18-inch barrel-drain, is the same as in the case of the girder-covered way.

The side walls of the brickwork-covered way are put in in the same manner as those for the girder-covered way already described, their curved inner faces being built to properly supported wooden templates, having each course marked on them, and each furnished with a plumb-line for setting it upright. These templates extend higher than the side wall proper, and the upper part of each of them is recessed to receive lagging-boards, upon which that part of the arched covering near the springing can be built. To allow of the remainder of the arch being built, the core left between the side walls is rounded off at the top, and is spanned by centring formed of light plate-iron ribs carrying the usual lagging-boards. The ends of the ribs are supported by timbers extending from the footings of the side walls and furnished with the usual striking-wedges; and each rib is jointed at the centre, and is supported at that point by means of foot-boards and wedges resting upon the top of the central core. This plan enables the greater part of the core to be left in its place until the completion of the covering, as in the case of the girder-covered way, so that it can be removed afterwards by end excavation.

We have said that the short length of brickwork-covered way near Buckingham Row is succeeded by about 160 yards of open cutting, the railway being for this distance carried between retaining walls. The retaining walls are constructed in bays, each bay being formed of an arched panel abutting against counterforts, as in the case of the side walls of the girder-covered way. At the back of the walls the counterforts are two and a half bricks thick, whilst in front of the panels the thickness is increased to four bricks. The depth of the counterforts, measured from the face to the back, varies according to the depth of

the excavation, and the rule which has been followed is, to make the depth of the counterforts at the rail-level = ⅓ the height of the retaining wall + 18 inches. The height here taken is the height above the level of the rails of that portion of the wall which is built in bays, and the top of which is generally about 18 inches below the ground-level. Above the retaining wall there is a parapet wall. The backs of the counterforts are carried up perpendicularly, and their front faces have an uniform batter of 1 in 8, so that the rule above given determines their depth from back to front at the top as well as at rail-level.

The counterforts are 11 feet apart from centre to centre, and the arched panels between them are one brick thick for a depth of 10 feet from the top of the retaining wall, and one and a half bricks thick below that depth. The versed side of the horizontally arched panels is 1 foot, and at their springing they are set back 1 foot 6 inches from the faces of the counterforts. The spaces behind the panels are filled in with lime concrete level with the backs of the counterforts, the same arrangements being made for drainage as in the case of the side walls of the girder-covered way. The distance between the faces of the counterforts of the opposite walls, at rail-level, is 25 feet, the distance between the walls at the top, of course, varying according to the depth of the excavation. The footings of the walls rest upon cement concrete carried down about 5 feet below the rail-level, as in the case of the side walls of the covered way. The parapet walls are 6 feet high above the ground-level, and are panelled, the panel being one brick, and other parts of the wall, except at the string-course and capping, one and a half bricks, thick. The retaining walls, like the side walls of the covered way, are constructed in trenches of sufficient width, the ground between these trenches being left for removal by end excavation. These retaining walls, and indeed all the details of the works, are admirably proportioned to the duty they have to perform, and by their construction very great resisting power is obtained with a comparatively small expenditure of material. The excellence of the design is also well matched by the quality of the workmanship, the whole of the brickwork which has so far been carried out in connection with the works of the Metropolitan District Railway, having been executed in a manner which reflects the greatest credit upon the contractors.

(To be continued.)

From the London Engineering, No. 46.

STEEL RAILS.

An order for twenty-two thousand tons of steel rails for the Great Indian Peninsula Railway was lately divided between the two great Sheffield houses, Messrs. John Brown & Co., limited, and Messrs.

Charles Cammell & Co., limited, and we understand that the last-named firm have orders for twenty-eight thousand tons of Bessemer rails now upon their books. Many of these orders, we are pleased to learn, are from America, for the Erie, New York Central, Pennsylvania Central, Boston and Worcester, Boston and Providence and other lines. The production of perfect steel rails is now a matter of the utmost certainty, and while very great hardness, to resist wear, is secured, the absolute strength is far beyond that of iron. At Messrs. Cammell & Co.'s, as at most steel rail mills, a "tup" of one ton is run up, by steam-power, to any height up to thirty-six feet six inches above the rail to be tested, and then tripped. The tup falls fair upon the rail, laid on three feet bearings, and it is very seldom that it is broken. It commonly bends so as to include an internal angle of about one hundred and twenty degrees. This enormous strength, where steel, in all forms, was once supposed to be peculiarly brittle, has removed the great objection to steel rails, and the fact that the American companies are ready to pay the full price shows that iron is now likely to be superseded.

The Woodhead tunnel of the Manchester, Sheffield and Lincolnshire Railway affords an interesting and instructive example of the great superiority of steel over iron rails. The tunnel, or rather, pair of tunnels, (for there are two,) are a few yards more than three miles in length, the gradient throughout being one in two hundred, and one down towards Manchester. There is a station at each end of the tunnel, and the heavy goods trains, as well as many of the passenger trains, generally stop in both directions. In getting away again, the consequent wear of the rails, just within the ends of the tunnel, is very considerable, the rails being constantly wet from the dripping of water from the roof, while they are also severely tried by the slipping of the driving-wheels of the heavy engines, the wear being aggravated by the free use of sand. Formerly not a Sunday passed without a number of rails being taken out or turned, and the life of an iron rail was but about five months on one head, and three or four on the other. Further in the tunnel, much of which is quite dry, although some portions are always showered with water from the roof, the average life of the rails was about nine months for one head and six for the other, or fifteen months in all.

Poor as the Manchester and Sheffield Company is, the directors resolved, nearly three years ago, to relay the Woodhead tunnel with steel rails throughout. The south tunnel was accordingly relaid in March and May, 1864, with seventy-five pound Bessemer rails, rolled by Messrs. Samuel Fox & Co., of Deepcar, near Sheffield; and the north tunnel was relaid at about the same time, the whole length of six miles eighty-eight yards of single line requiring about seven hundred and twenty tons of rails. The rails are of the usual double-head pattern, five inches deep, the heads about two and a half inches wide, and the stem five-eighth inch thick. They are in twenty-four foot lengths, supported upon cross-sleepers two feet nine inches apart at centres, except the sleepers which have the suspended fish-joint between them, these being two feet from centre to centre. The fish-plates and bolts are of iron. The rails are se-

cured in the intermediate chairs by compressed oak keys, in the usual manner. The ballast is mostly cinders from Messrs. Ashburys' great railway-carriage factory, at Manchester. It is of the usual thickness, and rests upon a layer of broken stone spread upon the millstone grit, which forms the bottom of the tunnel.

On Sunday last, by permission of the engineer of the line, Mr. Sacré, and in company with a gentleman well known in the profession for the interest he has taken in the introduction of steel rails, we went through the tunnel on foot, and having taken the usual precautions for the safety of the traffic, we took out rails at both the Dunford Bridge and Woodhead ends, purposely selecting the places of greatest wear. We had the original templates with us, and we took careful impressions from the ends of the rails, and measured them also, so as to obtain the exact wear. It was as nearly as possible one-eight inch off the upper table of each rail. The first rail taken up was put down at the Dunford Bridge end of the south or down tunnel March 20, 1864, and had borne twenty-four thousand and ninety-six goods, and ten thousand and forty passenger trains, as appeared from the books of Mr. Vernon, the station-master at Dunford Bridge. The goods trains were estimated at three hundred tons each, and the passenger trains at eighty to eighty-five tons, which is, we think, too low. This would give upwards of eight million tons of traffic over the pair of rails forming the line, or four million tons over the single rail taken up. The rail was in admirable condition, and was good for at least twice as much more wear upon the upper table alone, irrespective of what would be obtained from the lower table when turned over. The lower table was, however, a little indented at its bearings upon the chairs. The whole condition of the line was apparently perfect. The fish-joints were almost as close and secure as on the day they were made. It took two men, working their best, fifteen minutes to get the nuts off and the bolts out for each rail taken up. The fish-plates showed slight wear, and we really think that steel rails should have steel fish-plates, although there was little to complain of in the present instance. The line through the Woodhead tunnel is now the best portion of the Manchester, Sheffield and Lincolnshire Railway, and it is now frequently run by express trains in very little more than three minutes, or at the rate of sixty miles an hour, this speed being maintained, of course, only in the down tunnel and towards Manchester. Interesting as is this instance of the enormous superiority of steel over iron rails, it is but one of a great number which other lines now afford, and the time cannot be far distant when wrought iron rails will be almost as obsolete as the old cast iron trams of the early lines near Newcastle.

Mechanics, Physics and Chemistry.

For the Journal of the Franklin Institute.

DESULPHURIZING GOLD AND SILVER ORES.

REVIEW OF THE MOST RECENT ALTERATIONS MADE THEREIN BY DR. ADOLPHUS OTT, LATE ASSISTANT TO THE PROFESSOR OF CHEMISTRY AT THE ROYAL UNIVERSITY OF TURIN, ITALY.

Both practical miners and analysts have sufficiently proved that sulphurous gold and silver ores, when previously roasted, *i.e.*, freed of their sulphur, arsenic, antimony or other volatile substances, yield an incomparably larger amount of those precious metals than when treated directly by the amalgamation process. Whether the first of the above-named metals exists as distinct particles in its ores, though invisible to the naked eye, or whether it is combined with sulphur, generally found with it, science has not yet decided. Still, the latter is more probably the case, since two metals,* very similar to gold in their affinities, and hitherto only found in their metallic state, have recently been met in combination with sulphur.

Long before our American miners duly appreciated sulphurets and pyrites,† and attempted to extract from them the gold and silver they contained, auriferous pyrites were, according to Boussingault, worked by the inhabitants of South America, who, content with simply extracting the gold not intermingled with sulphurets, carelessly threw the tailings away in heaps. It was, however, subsequently discovered that, when thus left exposed to the influence of the atmosphere for eight or ten months, this undervalued refuse actually yielded an additional, and even an equivalent, amount of the precious metal.

Our miners, however, as soon as they were aware that their pyrites might be advantageously treated, began to experiment on various processes for desulphurizing ores. Vast sums of money were spent in procuring patents and in the erection of apparatus, which in many cases had to be transported for hundreds of miles. In the course of four years upwards of forty such patents for roasting have been granted by the

* Osmium and platinum.

† This is the common expression. It is derived from the Greek πυρίτης, a term applied to this mineral, because, as Pliny states, "there was much fire in it," as was made apparent by friction. This term was applied also to flint and some siliceous millstones on account of their external resemblance to copper pyrites.—Dana, *Mineralogy*.

Patent Office in Washington, many of which are already in general operation. To ascertain to what extent and with what success these several schemes have been carried out, is the purpose of this article. Knowing little or nothing of many of the processes patented in this country, but found in the lists issued by the Patent Office, we are at present obliged to pass them over without further notice. As, however, this article will be continued in following numbers of this publication, we hereby invite all interested in the subject, to favor us with drawings and a full description of their several processes. We shall give them every due consideration, and doubt not that, owing to the extensive circulation of this *Journal*, every patentee of a really valuable process will thus be personally, and it may be pecuniarily, benefited.

But before entering into detail, we will briefly allude to the nature of the sulphurets in which gold and silver exist. These are mostly the following: Iron pyrites, Fe″, (with 46·6 per cent. Fe;) vitreous copper, Cu′, (with 79·8 per cent. Cu;) copper pyrites, Cu′ Fe‴, (34·5 per cent. Cu, and 30·6 per cent. Fe;) purple copper, $Cu'^{3}\ Fe'''$; Bournonit, $Cu'^{3}\ Se''' + 2Pe'^{3}\ Se'''$. They are also found in gray copper, in arsenical iron, in tennantite and in copper blende. Occasionally they have been extracted from other minerals too numerous to mention. Sulphurets containing nickel and cobalt are not unfrequently met with in Colorado; in Nevada, arsenical and antimonial ores are known to exist, whilst quite recently a very interesting mineral has been discovered in Calaveras County, Cal., namely, a tellurite of silver gold, together with antimonial nickel, native tellurium, iron pyrites, free gold and tellurite of silver. This, however, differs in many respects from the tellurite of silver gold of Transylvania, with which most miners are familiar.*

Desulphurizing has three purposes, namely: Diminution of the state of aggregation, elimination of the volatile substance and oxidation of the remaining metals; and this process has to be so conducted as to secure the greatest amount of gold and silver. As the diminution of the state of aggregation is effected by any desulphurizing pro-

* It is a general observation that the nearer sulphurets are found to the surface, the richer they are in sulphur; but as we penetrate into the veins below the action of atmospheric influences, we find the signs of decomposition diminished, and pyrites appear in crystals of various sizes, and the quantity of gold in the ore also increases. To the decomposition of the pyrites, is due that peculiar change in the quartz, coloring it red, making it cellular and of a spongy structure, called by miners, in many instances, "honey-combed" or "burnt," wrongly supposing its peculiar appearance to be due to ignition.

cess based upon the action of heat, we will consider the various kinds of processes.

1. In regard to the consumption of fuel.
2. In regard to the degree of oxidation obtained.
3. In regard to the loss of gold and silver thereby occasioned.

But as the consumption of fuel depends chiefly upon the construction of the furnace, as the degree of oxidation obtained (provided we can get enough heat) depends principally upon the chemically acting agencies involved, and as the loss of precious metals depends upon both, we shall, after briefly describing the respective processes merely for the better elucidation of the subject, consider them—

1. In regard to the construction of the furnace.
2. In regard to the chemically acting agencies involved in the respective process; and
3. In regard to the loss of precious metals thereby occasioned.

I. THE VARIOUS PROCESSES PATENTED IN THIS COUNTRY, CHIEFLY AS REGARDS THE CONSTRUCTION OF THEIR FURNACES.

I. *Reverberatory Furnaces.**—Most of the furnaces for roasting patented in this country are reverberatory furnaces. In these furnaces, as is well known, the fuel is not in direct contact with the ore, but acts only by its flame, being separated from it by a low wall—the *fire-bridge*. The place on which the ore is spread is called the *hearth*. It is built of fire-proof materials and is flat or hollow, and covered by a more or less elevated arch of brickwork, by which means a portion of the heat is reverberated (from *réverbérer*) or thrown back; hence the name reverberatory furnace. The draft is necessarily in proportion to the diameter and height of the chimney. It is only recently that American inventors, rejecting the usual construction, have placed a cylinder of iron, glazed inside with materials not injured by the action of the sulphur, between the flue and the fire-bridge, this cylinder, which holds the ore, being turned by machinery during the operation of roasting. We shall consider these furnaces under—*b. Reverberatory Furnaces with Revolving Cylinders.*

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* Being the most simple, we ought first to consider those furnaces which are called "*Kilns*;" but as there has only been one proposed in this country for roasting, and as we are neither in possession of a full description nor drawing, though we have endeavored to obtain both, we must postpone our review of this kind of furnace for the next number. The patentee is Edward Kent, Esq., Melter and Refiner at the U. S. Assay Office, in New York, otherwise advantageously known by his "Gold Separator."

Various mechanical arrangements* for stirring the finely powdered ore have been introduced both in the former and in the latter kind of furnaces.

Of all the different kinds of construction, reverberatory furnaces are perhaps best adapted for roasting, because every kind of fuel can be used, the greatest effect of the fuel is obtained, the temperature can be easily regulated at will, and the whole operation supervised with the greatest facility.

a—ORDINARY FURNACES.

Rivot's Furnace is in operation in California. It is said that rock, paying $10 in silver per ton, could be worked to advantage in Europe, by subjecting it to Rivot's process. The furnace is so constructed that the flame cannot touch the ore in its passage from the fire-bridge to the flues, having a high fire-bridge, arch and flues, the arch being about thirty inches above the hearth, which is thirteen feet in size.

Hence it follows that there must be a great loss of heat by adopting this furnace.

The flame is also prevented from touching the ore by the introduction of steam of about fourteen pounds pressure per square inch, near the fire-bridge and through pipes, passing through the arch. Great importance is attached, and much credit taken, for the peculiar mode of introducing the steam into the furnace, it being said to form a protection against the access of air to the ore, Mr. Rivot considering it necessary that the air be *completely excluded* from the ore, in order to avoid the formation of sulphates, which are said to be injurious to the process of amalgamation.

With this we agree; but as concerns the plan adopted, if it is a really practical way to avoid the formation of sulphates, or rather, an impractical and costly one, we shall investigate under the appropriate heading. We only regret that Mr. Rivot has not furnished us with some details relative to his mode of creating combustion without any air entering into the furnace. If such a result can really be accomplished, it would be of no little importance to industry; but as Mr. Rivot merely gives us a rough statement, without describing any arrange-

* Mechanical arrangements for stirring the ore in ordinary reverberatory furnaces have long been in use in England. They are, however, now, for the most part, superseded by the American ones. We find such a one already described in the *Berg- und-Hüttenmännischen Zeitung*, 1852, page 265, and in C. F. Plattner's *Vorlesungen über allg. Hüttenkunde I.*, page 201.

ment, and as we know that, by the best improvements made in this line, the fire-gases which pass through the chimney always contain at least 10 per cent. of free oxygen, we have reason to doubt that Mr. Rivot fulfills what he assumes.

Corbett's Furnace, being twelve feet long by eight feet wide, is said to receive a charge of four tons of ore. In the construction of this furnace the arch is formed by a boiler, which is intended to supply the steam necessary for the propulsion of the machinery in crushing and amalgamating. Through the centre of the furnace extends longitudinally a hollow shaft, provided with arms, holding peculiarly shaped shovels, which also are hollow and kept constantly filled with water. They are intended by their oscillation to keep the ore in motion, while their spiral shape gives it a longitudinal direction.

It is said that the roasting of four tons of ore would be effected in five to six hours, and that twelve tons would be desulphurized in twenty-four hours. For roasting twelve tons three cords of wood are deemed necessary, and the total cost of roasting this quantity is said to amount to $42, while it is said it could not be done for less than $128 by the ordinary system.

In regard to this furnace, we find but little originality, except in the arrangement with the boiler forming the arch, but as its lower surface has to be lined with a fire-proof material, to protect it from the sulphurous vapors continuously generated, there can be but little heat saved. The mechanical arrangement for keeping the ore in motion is good, and there may be something new and peculiar in the form of the shovels. As the patentee claims that, by his process, compared with an ordinary furnace, two-thirds of the cost of roasting are saved, we would like to know what furnace he means, there being so many in use. Again, we cannot see why the oscillating shovels have to be constantly kept filled with water.

(To be continued.)

JOURNAL BEARINGS.

By Coleman Sellers.

At the stated meeting of the Franklin Institute, held October 19th, 1866, Mr. Nystrom made some interesting remarks on the use of a compound of cast iron and steel, for journal-boxes and the like. He

also gave a tabular statement of the properties of cast iron and steel, as compared with brass, which showed conclusively in favor of the former. At the conclusion of his remarks, I am made by the reporter to say: "Cast iron bearings work very well, and perhaps better than brass." As these words do not fully express what I said, and the subject is an interesting one, I propose to treat it more at large in these pages. In the infancy of the mechanic arts, wooden shafts or journals revolved in wooden boxes; wagon wheels, with hubs of hard wood, ran on wooden axle-trees. Then, cast iron boxes were driven into the wooden hubs, one at each end of the hub, and the wooden axle was plated, top and bottom, with wrought iron. But now, the model trotting wagon, which must run with the least possible friction, has a cast iron box the whole length of the hub, neatly fitted to a case-hardened wrought iron axle. Thus, in the history of the wagon, we see some little of the progress in perfection of journals.

Wood, stone, brass, cast iron, steel and various soft alloys, under the general name of Babbet metal, have been, and are still, used as journal bearings. Oliver Evans, in his *Millwright's Guide*, published in 1795, tells how to proportion the cast iron gudgeons (as the journals are called) of water-wheels, and describes the stone bearings in which they are to revolve, enlarging on the necessity of surface to resist the pressure of the weight of the wheel, and of the proper methods of conducting off the heat generated by the friction. The modern engineer is called upon to apply his knowledge of the nature of various materials for journal bearings, adopting such as each case may require.

Holding that the perfection of mechanism calls for a hardened cast steel journal, ground true, and polished—running in a hardened cast steel bearing, accurately fitted to the bearing, with the pressure equally distributed over the whole surface, so arranged as to admit of thorough lubrication. In general terms, the harder the surfaces of both journal and bearing, the better do they work. But as the cost is an essential consideration, other and cheaper methods have to be resorted to in practice. In the rolling machinery for iron, the massive rolls have their journals, or necks, as they are called, supported in hard brass boxes, the pressure being very great, from the enormous strain to which they are subjected in the process of rolling bars or sheets of iron and steel. These brass bearings rapidly wear out, and require to be renewed. To save the bearings, many compounds of copper, tin, antimony &c. have been tried, such compounds melting at a low temperature, and capable of being cast into cast iron cases,

to hold them in shape—presenting as the wearing surface to the journal a softer material than the brass. Such bearings do last longer than brass, and cost much less; but practice shows that the wear takes place in the journal of the roll, and not in the bearing, and thus the more expensive part of the machinery suffers. The reason of this is, the soft metal holds the hard particles of the dust and grit from the cinder &c. to which the journals are always exposed, each little particle becoming a cutting point to gradually wear down the hard metal of the journal; thus imitating the very means which a skillful workman would resort to, did he desire to grind down a similar mass of cast iron. The grinding clamps used by machinists to grind to size, cylindrical bars of hard metal, are usually made of cast iron, lined with soft metal—lead, for instance—and the emory used in grinding is held by the soft metal, which wears away very slowly in the process, while the cylinder of hard metal revolving in the clamps is quite rapidly reduced, just as the journal of the roll is worn down by the grit held by a soft metal bearing. Now, although these soft metal bearings do not answer for such purposes as the one just described, yet it does not follow that they are always to be avoided. There are cases in which they recommend themselves by their facility of construction and cheapness, and when they are protected from dust and grit they do not injure the journal.

The surface of journals and their bearings should always be proportioned to the work they have to perform, *i.e.*, to the pressure to which they may be subjected. A hardened steel journal in a hardened steel bearing, will work under a given pressure with less surface than would be required for a soft iron journal in a cast iron bearing. But when it is possible to obtain sufficient surface, the cast iron bearing, from its cheapness, ease of construction, hardness and that property which it possesses of rapidly giving off the heat from friction, recommends itself as best suited for the majority of cases.. To use cast iron successfully as a bearing, it should not be subjected to more pressure than about one hundred pounds to the square inch of surface exposed to the pressure, and the pressure should be uniform over the whole surface. All first-class machinists' tools—as, for instance, planing machines for metals—abound in examples of cast iron bearings, and in very many cases the bearings are made without any means of compensating for wear; that is, they consist of cylindrical holes in the solid metal, in which the journals fit accurately. And instances abound in which journals and bearings so made, have shown no appreciable

wear after years of hard work. In the construction of machines with rigid frames of metal, the journal bearings are mostly cast as part of the frame, bored in line with one another, and are what are called rigid bearings. When, however, the metal bearings are attached to wooden frames, as in the case of line shafting for conveying motion from the steam-engine to the various machines in a factory, the bearings should be so made that they can accommodate themselves to the varying positions of the shafting, and insure an equality of pressure over their surface. Bearings of this character, of cast iron, are now in almost universal use for shafting purposes, under the general name of swivel or ball and socket hangers. As the consideration of the proper proportion of the wearing surfaces to the work, in the use of these swivel hangers, may be interesting to some of the readers of this *Journal*, I shall reserve it for a separate article in the next number.

From the London Civ. Eng. and Architects' Journal, October, 1866.

ON TREATMENT OF MELTED CAST IRON AND ITS CONVERSION INTO IRON AND STEEL BY THE PNEUMATIC PROCESS.*

By Mr. Robert Mushet.

In the year 1815, my father, Mr. David Mushet, took out a patent for the manufacture of refined iron direct from the blast-furnace.

For this purpose he erected a small blast-furnace, 30 feet high, blown by means of three tuyeres, with a pressure of blast of about three pounds and a half per square inch. These tuyeres were arranged so as to dip down upon the surface of the melted iron in the hearth of the furnace, and when the hearth was full, or nearly full, the tuyeres were partially below the surface level of the melted iron. There was no difficulty experienced in keeping the melted iron in a liquid state in the middle of the hearth, but round the sides the refined iron chilled, and formed what is technically termed "scull," and this rendered it very difficult, and sometimes impossible, to tap the furnace and run off the portion of the metal which retained its fluidity. When the tapping took place, the metal flowed from the furnace intensely heated, and throwing off the most brilliant scintillations. The temperature of the metal, like that of ordinary refined metal, was far higher than that of pig iron produced under the regular working of a blast-furnace. The pigs of metal obtained were perfectly solid, showing, when broken, a dense white steely grain. They were so strong as to bend before they broke, and occasionally they could not be broken at all, though struck by the heaviest

* Read before the British Association, Nottingham, 1866.

sledges wielded by the most powerful men; the metal was, in fact, crude cast steel, and could be chipped with a cold chisel, and, when annealed, was susceptible of being forged at a low heat to some extent. The defect in this process was that, as in the refinery, the waste of metal was excessive, owing to the surface action of the blast upon the melted iron for a prolonged period. The difficulty of keeping the hearth open, and of tapping, arose merely from the small size of the furnace and hearth, and the weakness of the blast. The iron was, however, decarbonized, so as to be in the condition of crude cast steel, too highly oxygenated, however, to be forged into bars of commercial value.

The experiment I have described was, I believe, the first practical step taken in the development of the pneumatic process, though it was certainly not undertaken with any idea of producing either malleable iron or steel by that process, but simply a highly decarbonized refined metal. About the year 1850, I made experiments with some very highly-blown refined iron from the Parkend Ironworks, in the Forest of Dean, and found that, when alloyed with manganese, this refined metal could be forged into sound bars of very hard steel, too hard, indeed, for any practical purpose, but, nevertheless, solid, and free from seams or flaws, indicating that if the iron could be sufficiently decarbonized whilst in the melted state, steel of marketable quality might be obtained by simply adding some metallic manganese to the decarbonized metal.

In the autumn of 1856, Mr. Henry Bessemer read a paper at the meeting of the British Association in Cheltenham, which, whilst it filled the scientific as well as the practical world with astonishment, did not in the least surprise me, except in the one circumstance of its being possible to maintain a tuyere beneath a heavy column of melted cast iron. That, indeed, appeared to me most surprising, as I was well aware of the highly destructive action of the iron slag which is generated by the action of atmospheric air upon melted cast iron. However, what I considered impossible had actually been accomplished by Mr. Bessemer, and the first great advance towards rendering steel as cheap as iron had been inaugurated by that gentleman.

Mr. Bessemer's process consisted in forcing air through melted cast iron by means of tuyeres situated beneath the surface of the melted iron. When melted cast iron is subjected to this process, the silicon contained in the iron is first combined with the oxygen of the blast, and thrown to the surface as a light, frothy, gray slag. Next, the carbon of the melted iron enters into combustion, and, lastly, the iron itself is attacked and consumed with the development of an intense temperature, sufficient to keep the iron, though freed from carbon, in a perfectly liquid state.

When the silicon and the carbon have been nearly or wholly eliminated from the cast iron operated upon, the product obtained is either crude cast steel or iron, according to the degree of decarbonization arrived at. Ingots cast from this metal are more or less unsound, and, when forged, they frequently crack or break off, owing to their red-shortness, and are wholly unfit for the requirements of commerce. More-

over, whenever the melted cast iron operated upon contains sulphur and phosphorus to any notable extent, the decarbonized iron is found to be so crude and brittle that it cannot be forged at all, and is, in fact, less valuable than the pig iron it has been made from. Hence, only the purest coke pig irons of Great Britain are at present suited for Mr. Bessemer's process, and these are comprised in the hematite pig irons, the Forest of Dean pig irons, the Weardale spathose irons, and the Blanavon and Pontypool Welsh brands; these latter two being, however, far inferior to the other brands for the pneumatic process.

Mr. Bessemer naturally inferred that he should be able to produce both cast steel and iron by his process alone, and it by no means detracts from his merits that he happened to overlook the fact that iron exposed in the melted state to the action of oxygen becomes as it were debased. Some persons term it "burnt iron," but I call it "oxygenated iron;" and oxygenated iron can never of itself constitute a commercially valuable article. This oxygenation can be prevented when a metal is present whose affinity for oxygen is greater than the affinity of iron for oxygen, and it can be remedied when such a metal is subsequently added to the oxygenated iron. When Mr. Bessemer read his paper, I foresaw all the difficulties he would have to encounter from oxygenation of his iron, and I knew that the remedy was simple and attainable, provided a suitable metal could be found at such a cost and in such quantities as would render its use practicable on the large scale. Out of several metals possessed of the required properties, I selected the metal manganese as found abundantly in the spiegeleisen or spathose pig iron of Rhenish Prussia, and combined therein with carbon and iron, the iron forming a convenient vehicle by means of which I could introduce the metallic manganese into melted decarbonized iron treated by Mr. Bessemer's process. My first experiment was with some Bessemer metal prepared at the Victoria Ironworks from hematite pig iron. The experiment was made in small crucibles containing only a few ounces, the Bessemer metal being melted in one crucible, and the spiegeleisen in another; the melted contents of the crucibles were then mixed, and a small ingot cast. This ingot was forged into a bar of excellent cast steel, which was doubled, welded and made into a chisel, and was found for all practical purposes to be cast steel of fair average quality.

I then extended the scale of my experiments, and operated with steel melting pots, containing from 40 lbs. to 50 lbs. of Bessemer metal each, and melting the spiegeleisen in smaller crucibles. The most complete success resulted from these experiments, and Mr. S. H. Blackwell having subsequently supplied me with a small blowing engine, capable of maintaining a blast of 10 lbs. pressure per square inch, I operated upon quantities of melted cast iron of from 500 lbs. to 800 lbs., and with similar success, the Bessemer metal being wholly freed from unsoundness, red-shortness, and other defects which had precluded its being forged or rolled into a marketable product. The British pig irons that I found best suited for the joint processes of Mr. Bessemer and myself were the Lancashire and Cumberland hematite iron, the Weardale spathose iron

and the Forest of Dean pig iron. Of foreign brands, the Indian charcoal pig, and some manganese pig iron from Sweden, gave the best results, though not so satisfactory as those obtained when hematite coke pig irons were employed. I had, meanwhile, secured my invention by letters patent, dated September 22d, 1856. This patent lapsed in 1859, through non-payment of the stamp-duty of £50, owing to some unaccountable oversight of the trustees to whom I had been advised to entrust my patent rights. My invention thus became public property, and I was deprived by this accident of all remuneration for an invention which every person, practically acquainted with the manufacture of Bessemer metal, will admit to be of immense value.

I speak, no doubt, as an interested party, and my opinion is, therefore, open to criticism; but I venture to submit that an invention such as that described in my last patent, places all who have been benefited by its use under a moral obligation to recognize my claims to remuneration; for although by the accident of the non-payment of the stamp-duty my invention became public property, I still think that the accident ought not to debar me from the reward that I am morally entitled to, and could have commanded to so large an extent, but for the oversight of those on whom I relied.

Much remains to be done to extend the use of the pneumatic or Bessemer process to the ordinary brands of pig iron at present considered to be unfit for this purpose. I am, I believe, in possession of the requisite knowledge to accomplish all this, and I am only awaiting the opportunity to do so, whenever the Titanic Company, with whom I am associated, shall consider that the proper time has arrived for them to erect a suitable Bessemer apparatus at their works.

The means are, I believe, as simple and efficacious as is the addition of spiegeleisen, now invariably employed by all Mr. Bessemer's licenses in England, and the resulting advantages will be proportionally great.

In Sweden, the Bessemer process has been carried out by operating upon certain brands of Swedish pig iron containing a considerable alloy of metallic manganese; the result is, that with the subsequent addition of a little of the same manganesic pig iron in lieu of spiegeleisen, a workable steel is produced of moderate quality, but too seamy and unsound to be of much value for tools, and not nearly so tough and strong as the Bessemer steel made in this country from our own coke pig irons, and it can never enter into competition with our English Bessemer steel. In treating melted cast iron by the pneumatic or Bessemer process, the simplest plan is to deprive the iron of the whole of its silicon and carbon. In this case, the addition of a given weight of spiegeleisen, or of any similar metallic compound of iron and manganese containing carbon to a given weight of decarbonized cast iron, will ensure results of tolerable uniformity as to the hardness or temper of the steel produced. The effect of adding spiegeleisen to Bessemer metal is as follows:

The metallic manganese, by its superior affinity for oxygen, de-oxygenates the decarbonized metal, and renders it sound and free from red-shortness.

The carbon of the spiegeleisen steelifies the mixture, and improves it when stiff or hard metal is required.

The iron of the spiegeleisen adds to the weight of the charge, and may, therefore, be considered as a gain to nearly the amount of its weight.

The silicon which is found in spiegeleisen has the effect of reducing the boiling or agitation of the pneumatized metal when poured into moulds, and is therefore beneficial, and it is not present to any injurious extent in spiegeleisen.

The hardness or temper of the Bessemer steel may be increased at pleasure by increasing the dose of spiegeleisen.

When spiegeleisen is added to Bessemer metal containing sulphur, and the pneumatic blast is turned on so as to eliminate the carbon and manganese of the spiegeleisen, a portion of the sulphur of the pneumatized iron is carried off by the manganese, and thus, by repeated additions of spiegeleisen and subsequent eliminations of its manganese, pneumatized cast iron may be wholly desulphurized.

In a similar manner, Bessemer metal containing phosphorus may be dephosphorized by employing titanic pig iron in repeated doses to eliminate the phosphorus, and when both sulphur and phosphorus are present, both may be eliminated by repeated additions of spiegeleisen and titanic pig iron, the pneumatic blast being turned on after each such addition made to the pneumatized cast iron.

The pneumatic process of Mr. Bessemer, in conjunction with my spiegeleisen process, is producing a revolution in the engineering world, and in all the departments of art dependent upon engineering, to an extent almost incredible, and the magnitude of its ultimate effects it is impossible fully to foresee. Mr. Bessemer's name will be remembered in connection with this, the greatest metallurgical invention the world has ever seen; and I venture to hope that I may not be wholly forgotten as having supplied the link which was wanting to render Mr. Bessemer's process what it now is. As I have had much experience in matters relating to the steel manufacture, it was not surprising that I should at once have been able to devise the remedy for the one solitary defect which marred the success of the pneumatic process at its outset.

Translated for the Franklin Institute Journal from the Comptes Rendus, Vol. LXIII., page 771.

A NEW FORM OF THE HOLTZ MACHINE.

Memoir by M. Bertsch.

Notwithstanding the theory that its author gives of the Holtz machine, it appears to me a complicated solution of the problem I propose to solve. I have nevertheless tried, in the construction of this new apparatus, to banish all doubt about the action of its parts, so that one cannot mistake the origin of its effects. Also, though

analogous in form, it is easily seen that this generator is very different from that of which I have previously spoken, (*i. e.*, the Holtz machine.)

It is not composed of two disks of isolating substance, but of one alone, so that we need not consider the action of a layer of interposed air in the production of the phenomena. The disk, formed of a thin sheet of isolating material, is mounted on a shaft of the same substance, and can, by means of a handle or treadle, be rotated with the rapidity of ten or fifteen turns a second.

Two collectors with metallic points, but not connected, are placed perpendicularly to the plane of the disk, and at the opposite extremities of its diameter, and serve as the origin of the manifestation or display of the double current which is created. Each of these collectors is furnished with a movable arm, which serves as an electrode, each ending with a ball, and they separate from each other at right angles, or approach until they meet. A conductor with a large surface is connected with one of these poles to increase the tension.

Behind the plate, and parallel to it, can be placed, if desired, one or more sectors or thin plates of isolating material, not in contact with the last, but at a little distance from it. These movable sectors can act either alone, or superposed one on another. These sectors are of about sixty degrees each, and of a triangular form. They serve as inductors.

To start the machine it is sufficient to rub one of the sectors lightly with the hand, which electrifies its surface, and to place it in the position indicated. The wheel being put in motion, a series of sparks spring without intermission between the two electrodes. Whether the motion of the wheel is interrupted or no, the apparatus remains charged, as does the ordinary electrophorus. In a dry atmosphere, the flow of electricity will last for several hours without any sensible diminution; this seems to prove theoretically that it would continue indefinitely if the air was isolated in an absolute manner.

If behind the first we add a second sector, equally electrified by friction, the quantity of electricity is doubled, without, however, augmenting the tenison, because the surface of the conductor remains the same. A third and fourth sector superposed on the first, are so many new inductors, and augment the quantity, which is only limited by the distance of the electrified surfaces, the diameter, the rapidity of the wheel and the promptness with which it regains equilibrium by the electrodes.

With a disk of fifty centimeters (twenty inches) of hardened rubber,

and movement of ten turns a second and two sectors, you can obtain, almost without interruption, sparks of from ten to fifteen centimeters (four to six inches) having sufficient tension to pierce a piece of glass of one centimeter (?) thickness, and can illuminate continuously a tube of more than one metre (three feet three inches) filled with rarified gas, and set fire to combustible material at a short distance.

This plate can charge in thirty or forty seconds a battery of two metres (twenty-one and a half square feet) of interior surface, which will volatilize a sheet of gold leaf, and burn one metre of iron wire employed in the lightning arrester of telegraphs.

Finally, by the simplicity of its construction, this apparatus seems to realize practically the idea of a continuous electrophorus, and of a convenient and permanent source of electricity. By the effects, relatively of importance, which it gives, and the yet doubtful questions, on the induction of statical electricity, which it helps to solve, it seems to me of interest.

THE LAST SCIENTIFIC TOY.

We have just received from Wilson & Hood, No. 626 Arch Street, the last photographic novelty, in the shape of some cigar-holders made of paper and quill, each showing a blank medallion, on which, however, a photograph is developed in a few moments when the holder is used for its intended purpose. It appears from experiment that the ammonia of the smoke is the developing agent, but the exact nature of the action as yet defies the sagacity of the most learned in photographic affairs. These articles are sold for a trifle, and form a good addition to our already long list of scientific toys.

From the London Engineering, No. 46.

FILTERING WATER.

The success with which animal charcoal has been employed for filtering the East London Company's water, as supplied to the seven hundred occupants of Miss Burdett Coutt's model lodging-houses in Columbia Square, has been remarkable. Dr. Frankland has found (and we drew attention to the fact in *Engineering* of the 26th ult., page 325,) that the solid impurities were reduced from 30·2 grains per gallon to

21·76 grains, the organic matter from 1·25 grains to 0·28 grain, and the hardness (*i. e.*, the number of grains of bicarbonate of lime or its equivalent in one hundred thousand parts) from 20·2 to 7·1.

One of the most energetic purifiers of water by filtration is Mr. Thomas Spencer's artificially prepared magnetic oxide of iron. Filter-beds, in which layers of this material are overlain by sand, are now in use at Wakefield, Southport and Wisbeach. In the case of Wakefield, supplied from the Calder, the water as it is taken from the river is very impure. Mr. Filliter, the engineer to the Wakefield water-works, as he is also to those of the Corporation of Leeds, has two filter-beds of five hundred square yards each, at Wakefield, having each a layer of nine inches of Mr. Spencer's oxide overlaid with sand. Two more beds, of six hundred square yards each, are to have a layer of oxide of the same thickness, and thus nearly half an acre of filtering oxide will soon be in use in Wakefield alone. The effect upon the water is magical. It is not only cleared in appearance, but its organic impurities are nearly all removed. At Southport the water contained carburet* of iron, which turned the tea made with it to the blackest of ink. This has been also removed by the oxide of iron.

In preparing his oxide, Mr. Spencer calcines red hematite ore along with hard-wood sawdust for five or six hours in a close retort. This is all that is required to convert the ore into a black granular mass, which is strongly magnetic. Delivered at the works where it is employed, the cost is about £4 per ton.

From the London Chemical News, No. 351.

ON THE ABSORPTION AND DIALYTIC SEPARATION OF GASES BY COLLOID SEPTA.

By Thomas Graham, F.R.S.

It appears that a thin film of caoutchouc, such as is furnished by varnished silk or the transparent little balloons of india rubber, has no porosity, and is really impervious to air as gas. But the same film is capable of liquefying the individual gases of which air is composed, while oxygen and nitrogen in the liquid form are capable of penetrating the substance of the membrane, (as ether or naptha does,) and may again evaporate into a vacuum and appear as gases. This penetrating power of air becomes more interesting from the fact that the gases are unequally absorbed and condensed by rubber, oxygen 2½ times more abundantly than nitrogen, and that they penetrate the rubber in the same proportion. Hence the rubber film may be used as a dialytic sieve for atmospheric air, and allows very constantly 41·6 per cent. of oxygen to pass through, instead of the 21 per cent. usually present in air.

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* The writer no doubt means Carbonate.—Ed., H. M.

The septum keeps back, in fact, one-half of the nitrogen, and allows the other half to pass through with all the oxygen. This dialysed air rekindles wood burning without flame, and is, in fact, exactly intermediate between air and pure oxygen gas in relation to combustion.

One side of the rubber film must be freely exposed to the atmosphere, and the other side be under the influence of a vacuum at the same time. The vacuum may be established within a bag of varnished silk or in a little balloon, the sides being prevented from collapsing by interposing a thickness of felted carpeting between the sides of the varnished cloth, and by filling the balloon with sifted sawdust. For commanding a vacuum in such experiments, the air-exhauster of Dr. Herman Sprengel* is admirably adapted. It possesses the advantage that the gas drawn from the vacuum can also be delivered by the instrument into a gas-receiver placed over water or mercury. The "fall tube" has merely to be bent at the lower end.

The surprising penetration of platinum and iron tubes by hydrogen gas, discovered by MM. H. Sainte-Claire Deville and Troost, appears to be connected with a power resident in the same and certain other metals to liquefy and absorb hydrogen, possibly in its character as a metallic vapor. Platinum in the form of wire or plate at a low red heat may take up and hold 3·8 volumes of hydrogen, measured cold; but it is by palladium that the property in question appears to be possessed in the highest degree. Palladium foil from the hammered metal, condensed so much as 643 times its volume of hydrogen, at a temperature under 100° C. The same metal had not the slightest absorbent power for either oxygen or nitrogen. The capacity of fused palladium (as also fused platinum) is considerably reduced; but foil of fused palladium, for which I am indebted to Mr. G. Matthey, still absorbed 68 volumes of gas. A certain degree of porosity may be admitted to exist in these metals, and to the greatest extent in their hammered condition. It is believed that such metallic pores, and indeed all fine pores, are more accessible to liquids than to gases, and in particular to liquid hydrogen. Hence a peculiar dialytic action may reside in certain metallic septa, like a plate of platinum, enabling them to separate hydrogen from other gases.

In the form of sponge, platinum absorbed 1·48 times its volume of hydrogen, and palladium 90 volumes. The former of these metals, in the peculiar condition of platinum black, is already known to take up several hundred volumes of the same gas. The assumed liquefaction of hydrogen in such circumstances appears to be the primary condition of its oxidation at a low temperature. A repellent property possessed by gaseous molecules appears to resist chemical combination as well as to establish a limit to their power to enter the minuter pores of solid bodies.

Carbonic oxide is taken up more largely than hydrogen by soft iron. Such an occlusion of carbonic oxide by iron at a low red heat appears

* Chemical Society's *Journal*, ser. 2, vol. iii., p. 9, (1865.)

to be the first and necessary step in the process of acieration. The gas appears to abandon half its carbon to the iron, when the temperature is afterwards raised to a considerably higher degree.

Silver has a similar relation to oxygen, of which metal the sponge, fritted but not fused, was found to hold in one case so much as 7·49 volumes of oxygen. A plate of wire of the fused metal retains the same property, but much reduced in intensity, as with plates of fused platinum and palladium in their relation to hydrogen.—*Proceedings of the Royal Society.*

From the London Engineering, No. 41.

DISTILLING SEA-WATER.

In the northern part of Chile, near the coast, rain seldom or never falls, and fresh water, in large quantities, is nowhere obtainable. On the opening of the Copiapo Railway, from the port of Caldera inland, it became necessary to distill sea-water for the supply of the locomotives, and the quantity distilled at length became as much as 15,000 gallons daily. As coal on the coast costs from 12 dollars to 15 dollars per ton, the process of distillation was in any case an expensive one; but the mode of distillation was such, that as much as 40 lbs. of sea-water were, we are informed, sometimes evaporated per pound of coal, so that the cost was not as great as would at first sight appear. This rate of evaporation would, of course, be impossible, except with special evaporating apparatus, the action of which may be easily understood. The engineer to the line, Mr. W. W. Evans, ordered from Mr. A. M. Perkins, of London, five steam boilers, four of which contained each a large number of condensing tubes, instead of the usual furnace and fire tubes. Indeed, these four boilers were true surface condensers, although the steam was condensed in them into hot water of considerable temperature and under considerable pressure. The boilers were all thickly clothed with felt and ashes to prevent radiation, and were filled to the usual water level with sea-water. A fire was maintained in the furnace of the first boiler of the series, and the water in it was thus evaporated under a pressure of perhaps 100 lbs., and at the usual rate of 8 or 9 lbs. per pound of coal. The steam was led into the tubes of the next boiler, where it imparted its own heat to the sea-water surrounding the tubes, and thus raised steam, which was maintained at a somewhat lower pressure than that in the first boiler. Thus, suppose the steam in the first boiler to be at 100 lbs. pressure, and to have a temperature, as it rose from the brine, of 345°, (being a little higher than the temperature of steam rising from fresh water under the same pressure,) and suppose the steam in the second boiler to stand at 65 lbs. and at 315°. Here is a difference of temperature of 30°, sufficient for condensation, and thus all the steam from the first boiler would be condensed into water of 345°, or a little less. In condensing it would give off rather more than

875° of latent heat to the water in the second boiler, so that each pound of steam condensed would generate, from feed-water at 70°, about ¾ lb. of additional steam of 65 lbs. pressure. The third boiler might be worked at 35 lbs. and at 280°, the fourth at 14 lbs. and at 250°, and the fifth at atmospheric pressure and 220°, (according to the saltness of the water, fresh water boiling at 212°.) In this way there would be a difference of 30° or more between each successive pair of boilers, a difference sufficient to insure condensation as the steam raised in one was let into the tubes of the boiler worked at the next lower pressure. As lower and lower temperatures were met in the series of boilers, each pound of steam used for heating would successively give off a higher proportionate quantity of steam in the boiler next below it. Thus, if one pound of steam in the fired boiler would generate three-fourths of a pound of steam in the boiler worked at the next lower pressure, the steam from the latter would generate, not three-fourths as much as the fired boiler, but rather more than three-fourths its own weight in the third boiler in the series. This is supposing the water to be fed to the boiler in each case at a moderately low temperature, say 60°, and supposing the condensed steam to be taken off at the temperature of condensation, say 220 to 345°, in the different boilers. If, however, the high temperature of the condensed steam were utilized in heating the feed-water, a higher proportion of the heat of each pound of steam would be extracted from it.

Mr. Evans has informed us that as much as 40 lbs. of water were evaporated per pound of coal, in the case of the range of boilers at Caldera; but we believe no definite report has ever been made upon their performance. We do not even know the exact pressures at which they were worked, and we have taken the pressures already mentioned only for illustration. Supposing a difference of temperature of 10° or 15° to be sufficient for the active condensation of steam, then a lower range of pressures would not only suffice, but would give better results than we have roughly estimated, results which show about 25 lbs. to 30 lbs. of water evaporated per pound of coal, without reckoning the considerable loss by blowing off to prevent salting.

From the London Journal of the Society of Arts, No. 689.

(Continued from Vol. LII., page 387.)

CANTOR LECTURES—SUBMARINE TELEGRAPHY.

By Fleeming Jenkin, Esq., C.E., F.R.S.

5. *Proposed Improvements.*—Reels have been proposed in ships as a substitute for the coils in tanks. Their great mass in motion would be difficult to control. Mr. Siemens actually tried, with some success,

a reel for a light cable, and drove it with an engine; he abandoned the plan for the old system. The defects which the reel is supposed to remedy do not exist. Captain Selwyn has proposed to use a reel floating in the sea, ingeniously retarded by paddles, which would prevent too much slack from being laid. It hardly becomes a landsman to tell a sailor that such a reel would be unmanageable; but the difficulties of coiling in water, of launching the reel if coiled on land, of protecting the surface of the cable against collisions, of testing the cable, of remedying any deefct, should any arise, and even of preventing one coil from cutting into those immediately below it, seem unavoidable, and the defects the invention is supposed to remedy are imaginary. Buoys have been proposed to relieve the cable from part of its weight; any hollow buoys would be crushed very shortly after leaving the surface. Mere wooden floats would do little, and be difficult of attachment. This invention also labors under the disadvantage of being unnecessary, since cables can be paid out with twelve hundred weight strain or less, which will bear one hundred and fifty hundred weight. Vanes on a cable, opposing its slipping backwards, would be correct in principle, although probably quite impracticable; the result aimed at is obtained by increasing and roughing the surface of the cable. Most engineers who have had practical experience deprecate any attempt to catch the cable by nippers after it has left the ship. The danger of fouling is more considerable than the extra chance of safety given by the nipper. Lastly, many proposals have been made for some kind of elastic arrangement, to compensate for the change of strain caused by the rise and fall of the ship. When cables are paid out so nearly horizontally as is now the case, these arrangements, even if practicable, are not required, the alteration of the strain, caused by the motion of the ship, is quite inconsiderable, and there is great difficulty in devising any elastic arrangement which by the inertia or momentum of its parts would not aggravate the evil, such as it is. Unless when going very slow, in very bad weather, the best conceivable elastic arrangement would be useless, if not injurious.

6. *Repairs in shallow water.*—So long as the outer wires of a cable remain sound, repairs in shallow water are always easily effected. The cable is caught by a grapnel, lifted to the surface, cut, tested, and if the fault be near at hand, one end of the cable is buoyed, the other end passed round a drum driven by a steam-engine, which gradually hauls in the cable till the fault is found, when it is repaired, the cable again paid out, and spliced at the part buoyed. Bad weather and a rocky bottom are the chief difficulties to be contended with. Sometimes the cable is not cut or hauled on board, but simply underrun, passing over a grapnel or sheave hung outside the bows of the ship; as the ship moves forward the cable rises in front and is again lowered behind the ship. There are many points of practical interest connected with repairs in shallow water, and the lecturer refers those who require further details to Mr. F. C. Webb's paper in the *Transactions of the Institution of Civil Engineers*, 1857-58. If the bottom be good, *i. e.*, sandy or muddy, cables can always be recovered within one hundred fathoms, and they are frequently hauled up in much greater depths.

7. *Repairs in deep Seas.*—The only method hitherto practised with success has been to commence in shallow water and gradually haul the cable on board, as described above. By carefully keeping the cable hanging vertically from the bows the strain on it will not greatly exceed in calm weather the weight of the cable hanging plumb from the ship. Cables have been recovered in this way out of depths of one thousand and one thousand five hundred fathoms at the rate of about a mile per hour. Messrs Newall were very successful in the Mediterranean in recovering many cables by this plan, and the lecturer has seen a cable hang for three days at the bows of a ship where the depth was eight hundred fathoms, while the ship pitched violently owing to bad weather; the cable did not break, and was relaid with success. Even in this case the rise and fall of the ship did not injure the cable, but the change in the strain on the cable was great, and any good elastic compensation would have been useful; the cable itself, yielding say one-quarter per cent. in a mile, gives a certain elasticity. Although this method of recovering deep sea cables is not hopeless, the risks are great; bad weather or a weak point in the cable entail almost certain failure. A good nipper to catch the cable, should it break in board, as it frequently does, might be of material service. Few persons will be sanguine enough to expect that a cable could be steadily picked up for one thousand consecutive hours, or say forty days, with about half its theoretical breaking strain necessarily always upon it. We should, therefore, be grateful to the engineers in charge of the late Atlantic expedition for showing us that even in two thousand fathoms of water the attempt to hook a cable with a grapnel is far from hopeless. The chance of success by this method will now be examined. If a cable were laid absolutely taut along the bottom of the sea, when hooked by the grapnel it would rise a little way in virtue of its elasticity; if it stretched one per cent., by the time ten miles of it were off the ground the apex would be half a mile from the ground, a result few are prepared to expect; but the strain on the cable where caught would be very great, equal to the weight of about twenty-four miles of the cable, though the weight on the grapnel rope would be only that of ten miles of cable. The result, therefore, of trying to raise a cable such as the Atlantic laid taut, would certainly be to break it; but cables are not laid taut in deep water, and the Atlantic is laid with a mean slack of about twelve per cent., and in the last days we may even count on fourteen or fifteen per cent. slack; that is to say, for every hundred miles passed over, one hundred and fourteen or one hundred and fifteen miles of cable were laid. Lay on the floor one hundred and fourteen inches of chain, between two points one hundred inches apart, lift it in the middle on a hook, the two ends will hang down in catenary curves, and when the cable at the extremities is just off the floor, the hook will be 23·3 inches from the floor. Quite similarly a cable laid with fourteen per cent. slack will, when caught by the grapnel, hang in two half catenary curves, and by the time 11·4 miles of the cable are off the ground, the grapnel will be two thousand three hundred and thirty fathoms from the bottom, *i.e.*, at the surface

TABLE VII.—*Giving length of Cable lifted with a given slack, and hanging in a catenary curve, &c.*

Slack in per centage.	Tension at highest point in terms of the weight of a length of Cable hanging vertically from the surface to the bottom.	Length of curve in terms of versine.	Length of versine of span 100.
0	Infinite.	Infinite.	0
1	47·6	19·42	5·2
2	20·8	12·75	8·0
3	13·5	10·20	10·1
4	10·0	8·74	11·9
5	8·18	7·84	13·4
6	6·90	7·16	14·8
7	6·01	6·64	16·1
8	5·39	6·24	17·3
9	4·88	5·92	18·4
10	4·52	5·67	19·4
11	4·18	5·43	20·45
12	3·89	5·21	21·5
14	3·49	4·89	23·3
16	3·12	4·58	25·3
18	2·89	4·37	27·0
20	2·67	4·17	28·8
22	2·48	3·98	30·6
24	2·39	3·89	31·9

TABLE VIII.—*Showing the length of a catenary curve of constant span equal one hundred, with various deflections at the centre, and giving strains at highest point in terms of the unit length of chain.*

Proportion of versine to span.	Length of versine or dip.	Length of curve.	Strain at highest point in terms of the unit length of chain.
0	0·00	100·0	Infinite.
1/12	8·33	102·1	160·9
1/11	9·09	102·6	149·3
1/10	10·00	103·0	137·6
1/9	11·11	103·4	125·8
1/8	12·50	104·3	115·2
1/7	14·29	105·4	104·3
1/6·5	15·38	106·4	99·7
1/6	16·67	107·3	94·5
1/5·5	18·18	108·9	90·5
1/5	20·00	110·4	86·2
1/4·5	22·22	112·4	82·1
1/4	25·00	115·4	79·1
1/3	33·33	125·4	75·6
1/2	50·00	177·3	103·5

of the Atlantic. The strain on the grapnel rope will be the weight of the cable lifted, or about 11·4 miles; the strain on the cable itself at the point of suspension will be much less, being only about three and a half times the weight of the cable hanging vertically, or say eight miles of cable. (Observe that the strain on the cable and the weight of the cable are not synonymous. When the two ends hang plumb, the strain on the cable at the top is half the weight of the cable carried. When there is little slack, the strain is much greater than the weight carried.) If the depth were only two thousand fathoms, the strain on the cable when brought to the surface would only be equal to the weight of about seven miles of cable. Moreover, the actual cable is not held at any point except by its own weight, and there will be a pull at the bottom tending to haul in slack towards the grapnel amounting to several tons. But even without counting upon slack obtained in this way, it is clear that if the cable will bear eleven miles of its own weight, it could, under favorable circumstances, be hauled to the surface by a single grapnel.

Tables VII. and VIII. give the proportions and strains on catenaries in various convenient practical forms. Thus, from Table VII. we see that if ten per cent. slack be laid, the maximum tension on the catenary lifted in, say one mile, will be the weight of 4·52 miles of cable. In two miles depth the strain would be the weight of 9·4 miles of cable. In in the latter case, $2 \times 5{\cdot}67 = 11{\cdot}34$ miles of cable will be off the ground, and the grapnel rope must be strong enough to bear this. Table VIII. gives a similar information, supposing we do not start from a definite per centage of slack, but know the proportion of the dip made by a rope to the strain.

(To be continued.)

BLACK'S COMBINED ELLIPTIC AND CORRUGATED SPRINGS.

To APPRECIATE fully the merits of the combination above named, we must in the first place, understand the difficulties existing in springs of a different construction.

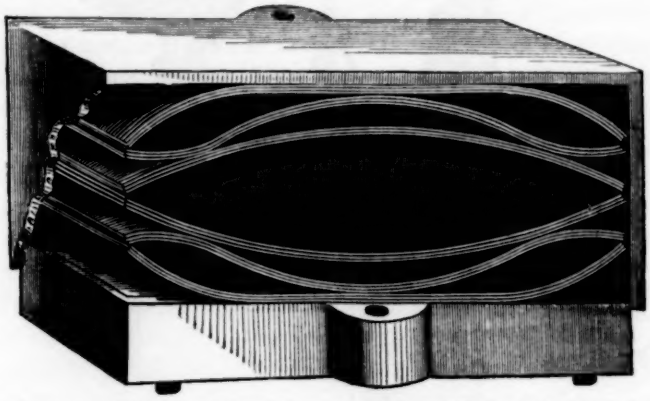
In the spiral spring, the elastic force of a single coil expresses the elastic force of the whole combination, and thus a weight capable of closing one coil will close any number. These springs have thus too little range of action. Being properly loaded with dead weight, a slight jar will close them, and they will become entirely useless.

To remedy this difficulty, spiral springs have been occasionally stuffed with wool, but this soon becomes packed and loses its elasticity.

The ordinary form of compound plate spring avoids this to some extent, by the arrangement of the plates, which, as the spring closes,

distributes the strain in such a manner, that the elastic force acting at greater advantage, offers an increasing resistance to the closing force. Thus, as the strain increases, the various blades of each half are flattened down upon each other, and as they come in contact they become practically united, thus producing a thicker and stiffer spring. But even here the remedy is not perfect, the maximum power of the central blades being the limit of available resistance.

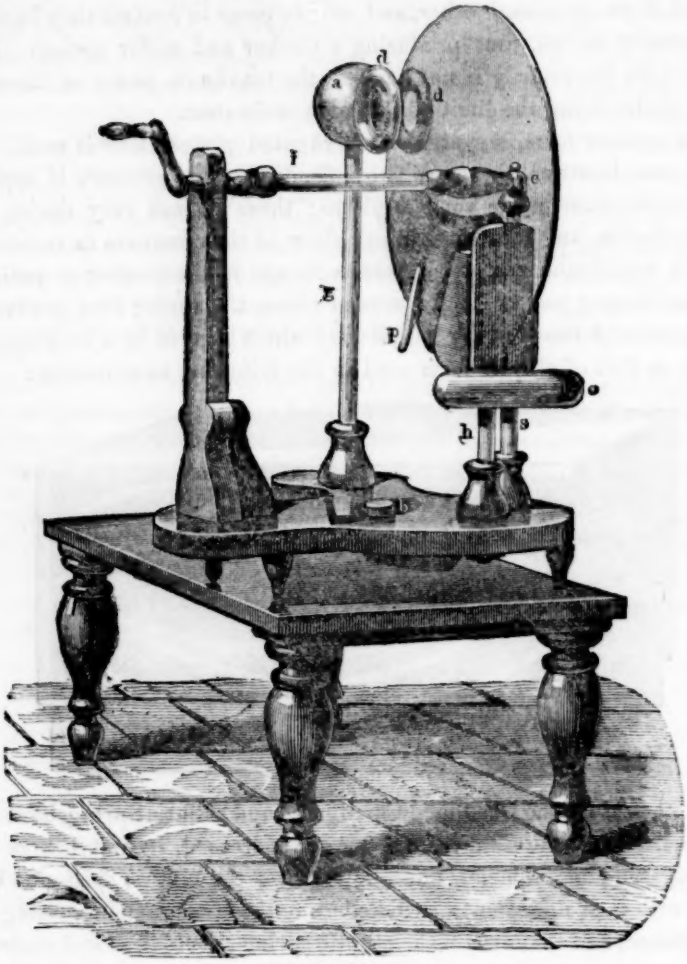
In another form, a system of corrugated plates alone is used. In this case, however, there are two difficulties. The pressure is applied at single points in the various plates; these do not vary during the compression, and therefore do not allow of that increase in resistance which would otherwise occur from a change in the number or position of the bearing point. In the second place, the spring thus produced, wants that delicacy under a light load which is given by a long spring, such as that of elliptic form used in the following combination:



In the case of the Combined Corrugated and Elliptic Spring, however, we see, that as the compressing force is increased, it first brings the corrugated plate, which is immediately over the elliptic spring, in contact with it at new points, so distributing the strain and increasing the resistance, and that even if the elliptic spring should be closed entirely, the corrugations of the plates would still continue to act as short, and therefore very stiff, springs; so that the range of action would, in this way, be vastly increased.

This combination may also be made to vary in delicacy or in strength to any degree, with great ease, by increasing the number of sets of springs and corrugated plates, for greater delicacy, and by increasing the number of elements in each set for greater strength; as by making each elliptic spring, and each corrugated plate, consist of several thicknesses.

Educational Department.



THE AUSTRIEN MACHINE.

LECTURES ON ELECTRICITY AND LIGHT.

DELIVERED BEFORE THE FRANKLIN INSTITUTE,

BY PROF. HENRY MORTON, PH.D.

IT is my purpose, in the present course of lectures, to associate, as far as their natural relations would suggest, the phenomena of Light and Electricity. There is so much in common between these two, and

yet so much of difference in our ordinary conceptions of them, that an association, if natural and not too much constrained, may at least be of value as an aid to memory and a simplifying of ideas. For the sake of perspicuity and brevity, I propose to begin with the statement of such a theory as appears best suited to a popular treatment of the subject, and then will illustrate this by various explanations and experiments.

Before stating the theories which I propose to use, I wish to make some explanations as regards their scope, character and reliability. A theory may, if it is absolutely true, act as a guide to discovery, and lead directly, by applications of its dicta, to the knowledge of new facts. Good examples of such results are furnished in the discovery of the planet Neptune, by LeVerrier, on the basis of Newton's theory of universal gravitation, and in the prediction of Poisson concerning the diffraction of light, founded on the Undulatory theory of Huyghens.

Again, a theory, whether true or false, may be of great use as an aid to the memory, and to the mental conception of a complicated subject. It may serve, in fact, as a string, which will enable us to tie the facts together, and also to gather them easily into the hand.

A theory may possess both of these characters at once, or only one of them.

The first is the case with the now universal theory of light, the Undulatory or Dynamical theory. With regard to Electricity, however, we have not, as I think, any such fortunate hypothesis. The theory of Faraday, which can, perhaps, best lay claim to the first character of probable accuracy, is itself far too abstruse, involved and indefinite, to merit the latter distinction, and that of Du Fay, while admirable for its clearness and simplicity, does not impress us with a sense of its absolute reliability.

Being therefore obliged to make a choice under these conditions, and remembering that my office is not to guide you into new fields of labor and discovery, but rather to lead you, by the most pleasant paths possible, over the ground already won by stronger hands than ours, I have determined to employ that theory which will ask of us the least, and yield to us the earliest fruit; knowing, that even if subsequently it is to be abandoned, it will nevertheless have given us good assistance in its time, and, like a last year's suit, will be entitled to an "honorable discharge," even though out of fashion at this time. Though I make these limitations, I would not have you suppose that the theory to be presently stated is crude, improbable and unsupported by

the highest authority. It finds among its advocates and expounders, such names as De la Rive, Du Moncel, Becquerel, Daguin and a host of others, and finds *itself* in discord with no fact yet observed. These preliminary matters being disposed of, I will now proceed to the statement of the Double-fluid theory of Electricity first suggested by Du Fay, which may be made very clear and easy of comprehension, we think, by aid of an illustration.

The air, as you know, is not a simple substance, as the ancients believed, but is a mixture of two very opposite gases; one of them, Oxygen, being the most active of the elements, supporting and stimulating combustion, and concerned in almost every action of light and life; the other, Nitrogen, so opposite in all respects to this, that it has received among the French (and well deserves) the name of "Azote," or "lifeless."

These two, mingled as in the air, exhibit neither of their peculiar properties in a very strong degree; but, when separated, each shows its own in a marked manner. Again, though as a matter of fact these two gases do *not* readily combine, yet, for the sake of our illustration, we might easily suppose, that like many other dissimilar gases, they would unite with violence. If so, their union would, like that of other gases so combining, produce a violent motion of the surrounding air, such as we call a detonation, or sudden loud sound. This sound would finally be transmitted by the combined or mingled fluids, or by either separately. Sound, as you know, travels well in any gas.

Now, according to our theory of electricity, there is a fluid, or gas, extremely light and rare, pervading all space and all matter, which like the air, is made up of two different fluids, very distinct in some of their properties, though alike in others. These, when mingled or combined, neutralize each other, but each separated, shows its own powers in a clear manner. The chief properties of these fluids which we need now notice, are their attraction for all that is unlike, and repulsion for all that is like, themselves.

Thus, the particles of each fluid are mutually repellant, but attract those of the other fluid and matter generally. These fluids, again, travel freely through some bodies, such as metals, and are resisted in their passage over others, such as glass and shellac, and when they meet, combine, often with such violence as to cause those vibrations in the surrounding medium, which we recognize as light.

Lastly, this surrounding medium may be composed itself, of the

combined or mingled fluids, and transmit the shock of their union, as water does that of an explosive mixture of Oxygen and Hydrogen, or as air would that of its constituent gases, did they unite with energy.

Such being the ideas which we would propose, as affording a tangible basis on which we can build up some simple notions of electric force and its relations with light, we will proceed to the further discussion of the facts, in connection with the above general theory.

Assuming the existence of two light mobile fluids, which only exhibit their distinctive or electrical properties, when separated in some way, we find that three kinds of separation may be effected, and will give rise to three kinds or classes of phenomena.

In the first place, the fluids may be so separated that greater or less quantities of each may be accumulated and retained in different bodies. The phenomena which result from this condition, are known as those of Statical Electricity.

In the second place, the fluids may be so affected as to be set in motion in opposite directions, through a closed circuit, thus giving rise to Galvanic phenomena.

Lastly, such an action as the last may be established in the individual molecules of certain substances, and we then have Magnetic properties developed.

These various actions we will study in their order.

Statical Electricity.

When two substances are rubbed together, their natural charge of electric fluids is so separated, that an excess of one kind will accumulate in one body, and an excess of the other kind in the other substances.

Thus, this piece of amber, being rubbed with this woollen cloth, the positive fluid collects in excess in the cloth, while the negative in the same degree accumulates in the amber.

To prove this, I have recourse to an instrument, whose action is based upon the first property of the electric fluids already expressed, namely, that particles of the same fluids repel each other.

We have a glass flask, within which are suspended by a brass rod two strips of gold leaf. A plate of brass terminates the rod above.

Having "excited" the amber by rubbing, as before stated, we place it upon the brass plate, when at once, the gold leaf strips diverge, as is shown in the figure; thus proving their mutual repulsion and the presence of one electric fluid in excess. Then, removing the amber, and putting the woollen cloth in its place, we first find the

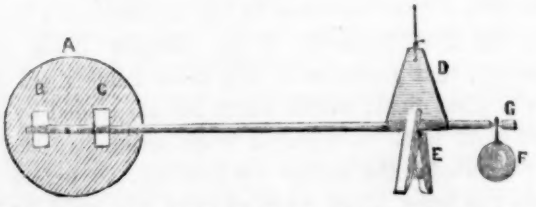
leaves collapse, because the fluid in them is neutralized by the opposite sort coming from the cloth, but then again expanding from an excess of the positive fluid, if the cloth is made to supply a sufficient amount.

In the apparatus as below figured, there is sometimes a difficulty, from the adherence of the gold leaves to the glass, when they diverge enough to touch it. This may be avoided by coating the interior, at these points, with some conducting substance in connection with the ground, as by silvering the lower part of the flask, and boring a small hole through the bottom, by which a strip of tinfoil may pass to the interior, or by cutting out the whole bottom, and then pasting strips of tinfoil where the gold leaves would strike, or the apparatus may be made from a small bell jar, similarly provided.

Fig. 1.

Another yet simpler piece of apparatus may be used for a like purpose. From some convenient support we suspend a straw, a fine glass tube or thread of shellac. At one end of this is a little ball of pith, and at the other a counterweight of tea lead, tinfoil or the like. If the excited amber is brought near to the ball, this body will be attracted by the excess of electricity in the amber, but after contact will be repelled; the amber and ball

Fig. 2.

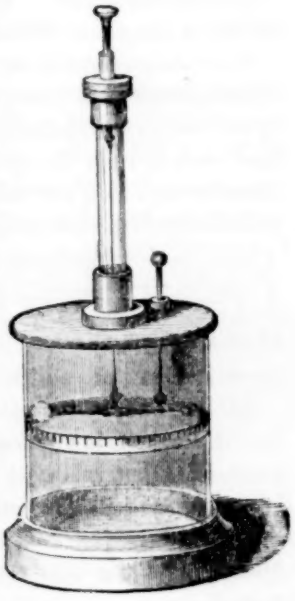


then both having the same kind, but in this condition the ball will be powerfully attracted by the cloth with which the amber was rubbed, this containing, an excess of the opposite fluid.

On the large scale, the pith-ball of the instrument above described

may be replaced by a disk of card, A, fastened to the glass tube by staples of paper, and varnished with shellac on its edge. The glass rod is supported in a stirrup of paper, D, and is prevented from slipping by a patent clothes-pin, attached as in the figure at E. To effect repulsion after contact, we must then have some large excited body, such as the plate of an "electrophorus," to be described subsequently.

Fig. 3.



When a small instrument, such as that first described above, is inclosed in a glass case, through which passes a brass rod and ball, by means of which an excited body may convey its action to the suspended pith-ball within; it forms a very delicate indicator of electricity, and is known as Coulomb's Electroscope, or, when the supporting filament is of wire, whose torsion may *measure* the repulsive force between the brass and the pith-balls, Coulomb's Electrometer. Its form is shown in Fig. 3.

By means of these various instruments, it is easy to illustrate the fundamental facts of Statical Electricity.

1st. We prove, by rubbing together all sorts of substances, and then applying them to these various instruments, that opposite fluids are invariably developed at the same time, and that all bodies are capable of this action. But we must take the precaution of insulating good conductors, such as metals, from the hand by glass handles, silk cloths and the like, or we shall lose into the ground the electricity developed, before it can be brought to the machine. If, in a dry, warm room, during cold weather, the finger is placed on the plate of the Gold-leaf Electroscope, Fig. 1, and the foot is drawn over the carpet, the leaves will diverge, and, under favorable conditions, sparks may even be given off from the hands, so as to ignite the gas at a burner; thus showing how easily electricity is developed by friction. Success in this and most other electrical experiments, depends upon the dryness of the air and of the apparatus used. Damp air and moist surfaces, carry away electricity as fast as it is developed. Thus, in the warm summer weather, when the air is full of moisture, all experi-

ments fail, not because no electricity is produced by our manipulations, but because it is all lost before we can use it.

The low temperature of the air in winter prevents it from holding so much vapor, and thus it is itself dry, and renders dry all apparatus exposed to its action. The common idea of a greater amount of electricity in the air in winter than in summer is then, not a true one.

The total *amount* of the fluids present in all bodies is invariable under all conditions; the changes we observe are only in the relative quantities of the two kinds. A positively charged body has more positive fluid than one not charged, but then it has as much less negative, for when rubbed with another to produce that excitement, the other acquired negative electricity, while the first secured positive. Thus, let | + — + — | represent two bodies in their natural state, then after | + — + — | friction they will be indicated thus, | + + + + | when each has as many particles in it as before, only | — — — — | these are now all positive in one, and all negative in the other.

2d. We find, by the same means, that the capacity for accumulating one or other of the opposite electricities, is not absolute in different substances, but relative; so that various kinds of matter cannot be separated into classes, one capable of developing the positive and the other the negative fluid, but must be arranged in order or series, beginning with the most positive, ending with the most negative, (or *vice versa.*)

Thus, any body in such a list or table, rubbed with one below it, will develop positive; with one above it, negative electricity.

Thus, in the following list, silk rubbed with sulphur acquires positive electricity; with smooth glass, negative electricity.

Table of some substances in their Electrical Relations.

Most Positive.—Fur,	Paper,
Smooth Glass,	Silk,
Woollen Cloth,	Lac,
Feathers,	Rough Glass,
Wood,	Sulphur.

Most Negative.—Gun Cotton, and like bodies.*

* The cuts in this article, except Fig. 2, are entered according to Act of Congress, in the year 1861, by J. B. Lippincott & Co., in the Clerk's office of the District Court of the United States, in and for the Eastern District of Pennsylvania.

THE MAGIC LANTERN

AS A MEANS OF DEMONSTRATION.

Conservatism seems to have been the characteristic of ancient science and civilization, but modern progress, on the contrary, has for its most conspicuous feature, a generous and unlimited diffusion of its treasures and acquisitions, among all. Especially is this manifest at the present time, when the deepest and most successful students of nature, find their greatest fame in the successful manner in which they have exhibited and made clear to the general public, the most momentous results of their labors. Witness Faraday's Lectures on the Physical Forces, and on The Chemistry of a Candle—Tindall's various lectures—those of Hoffman, Crace Calvert and many others too numerous to mention.

Under these conditions any instrument which largely assists in exhibiting to many at once, what must otherwise be confined to the close inspection of a few, and thus renders possible, the visible demonstration of a fact which must otherwise be only stated, is at once so eminently useful to the man of science in his relations with the *now* scientific public, and so in tune with the temper of the time, as to merit much attention and some study.

Such an instrument is the Magic Lantern in its improved form, now familiar to all; and it is with a view of putting on record some useful experiences which may avail others, and of inducing a more general employment of this instrument for the ends it is so eminently fitted to serve, by which its very efficiency will be itself increased through improvement and discovery, that the following pages have been prepared by one who has had many years of practical acquaintance, with the instruments and manipulations which he describes.

It is proposed to treat the subject in as thorough a manner as possible consistent with a purely practical view, spending no time over historic details and preliminary discussions, but going at once and fully into the *minutia* of manipulation and construction. We propose to describe the best means known to us, of preparing and storing the gases used for the light; the structure and management of jets; the arrangement of lanterns for different purposes, including the Gas-microscope

and Polariscope; the structure and management of various pieces of apparatus used with these; the means by which all optical laws may be demonstrated, and the operation of the electric and magnesium lights, and their scope of application.

Preparation of Oxygen Gas.

As yet no process has been devised, which meets the various requirements of the present demand for oxygen under existing conditions, so well, as that in which chlorate of potash, and black oxide of manganese are heated in a close vessel. The only subject worth discussion is therefore the character of the vessel and the method of heating. In these connections, however, we think that we may say something which will be useful and new to many.

The simplest process, as regards means and appliances, is that first suggested, as we believe, by Dr. Wilkinson, of New York, and frequently employed by him in the laboratory of Dr. Doremus. This consists in taking an iron tea-kettle, placing in it the mixture of chlorate and black oxide ($KOClO_5$ four parts, MnO_2 one part) luting on the cover with clay, or plaster of Paris, and securing this in position by a stick between it and the handle, connecting the spout with a large reservoir, tilting the kettle backwards on a large gas-stove or small furnace, and so driving off the gas. With several pounds of material, the gas comes off in terrible haste, but with perfect safety, as, long before any dangerous pressure could be reached, the handle would give way and open a thoroughly efficient safety-valve, namely, the lid of the kettle.

Next to this comes the usual **iron retort** about which there is little to be said, except that it requires a good fire to heat it, and cannot be managed with a common gas-stove or Bunsen burner. With a large Argand burner and steam blast it, may however, be heated sufficiently. For this purpose we provide a closed copper cup, capable of holding about one pint, and fitted with a tubular at the side for filling, and a fine jet at the middle of the top. Above and around this jet, is supported a large Argand gas-burner. A few ounces of water being introduced into the copper cup or boiler, the tubular is closed with a cork, and an alcohol lamp is placed below. When steam escapes freely, the gas is turned on and ignited, and a blast-lamp of great power is thus produced. The escape of oxygen from the iron retort being once fairly started, the heating apparatus may be removed, and the process will then finish itself.

The copper flask should next be noted. In this case, a "chemical lamp," gas-stove or Bunsen burner will give sufficient heat, and for this reason, as well as on account of its lightness and portability, this form of oxygen generator is much used.

We observe that many experimenters find a tendency to sudden and violent action characterizing these flasks, and we have ourselves experienced some trouble from this cause, but we think the difficulty may be avoided by the following means:

Use a mixture, as above, of four parts chlorate to one of black oxide, and then heat promptly and rapidly until the gas comes over freely; then remove the heater, but replace it again if the action slacks, removing again, of course, when this becomes rapid.

The violent action occurs, we think, when, from too gradual a heating, the whole contents of the flask is raised nearly to the point of decomposition before any part is decomposed, then when the action begins at any point, the heat developed causes it to extend at once throughout the mass.

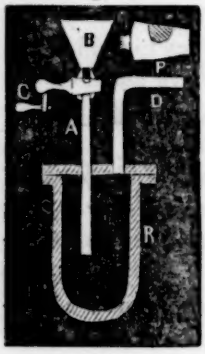
By rapid heating, on the other hand, the lower layers are decomposed before any heat reaches those above, and the action is thus successive and moderate; not constantaneous, and almost explosive.

The grinding process as it is commonly called, is very efficient, and, where very large quantities are to be worked, is almost essential. In this case we have an ordinary iron retort, R, (Fig. 1,) through the lid of which pass two iron pipes, one, D, the delivery tube, the other, A, having at its upper end a stop-cock with a plug, not perforated, but having a hollow or cup in it, as shown on the large scale at P. This plug has a handle or winch, and above it is a large tin funnel, B.

The retort being heated in a furnace, chlorate of potash is placed in B, and the handle, C, receiving one turn, as much of the salt as the cavity in P, holds, is allowed to fall into the retort. Another turn gives a fresh supply. A wash-bottle placed beyond D, enables the operator to see that the salt is being decomposed as it is introduced, and is not accumulating in the retort. This is the process used by Grant, of New York. He has a gas-holder of one thousand gallons capacity, which he charges in this way, and then pumps the gas into the iron reservoirs. A good modification of the above is that made and used by Mr. Debeust, assistant to Professor R. E. Rogers of the University of Pennsylvania, in this city. In this there is substituted for the funnel, B, a cylindrical hopper, closed above by means

of a screw-plug, and for the cock, C, a small wheel with wings or buckets. The whole quantity of chlorate to be treated, is placed in the hopper, which is then closed air-tight by the plug; then on turning the little wheel the salt is delivered piecemeal into the retort. The advantages are, that the wheel need not fit air-tight at first, and that no loss by leakage can occur, as with the other form, if the cock is worn.

Fig. 1.



This concludes all we can say from our own knowledge about apparatus for making oxygen. We should however, here mention a few precautions worthy of attention.

To make sure that the black oxide of manganese used is pure, and even, in fact, the substance named, and not sulphide of antimony or the like; mix a few grains with chlorate of potash and heat in a test tube. If a violent burning or explosion occurs, you have lost a test tube but perhaps saved your life, and will, of course, not use the dangerous material. If the gas comes off quietly, with a few minute sparks or glowing of the material towards the last, all is right.

The proportion of oxide and chlorate given above, *i. e.*, one part black oxide of manganese to four parts chlorate of potash, is a good one, but may be varied much either way without injury. The less oxide used the greater the chance of sudden action.

One pound of chlorate will yield about thirty gallons of oxygen, or will fill a thirty by forty inch gas-bag, made of pillow-shape. If the gas-bag is thirty by forty inches and of bellows or wedge-shape, it will take about one and a quarter pounds of chlorate to fill it full.

Fig. 2.

If the gas is to be run directly into gas-bags, it should be washed as thoroughly as may be, by means of wash-bottles, of which Fig. 2 shows a good form.

The brass cap, A, is cemented to the neck of a quart bottle, B, and has in it a tubular or outlet tube, C, for the escape of the gas, and another opening above, in which is fitted, by grinding, the bent tube, D G, by which the gas enters. The lower end of G, is pierced with a number of holes by which the gas escapes in minute bubble and is thus better washed. D G, is easily withdrawn, when the water is to be emptied out or replaced.

Franklin Institute.

Proceedings of the Stated Monthly Meeting, December 19th, 1866.

THE meeting was called to order with the President, Mr. William Sellers, in the chair.

The minutes of the last meeting were read and approved.

The Board of Managers presented their minutes, and reported, that at their Stated Meeting, held on the 12th inst., they elected forty-four new members of the Institute, and eighteen new names were proposed for election at the next meeting.

Donations to the library were received from the Institution of Civil Engineers; the Institute of Actuaries; the Statistical Society; the Society of Arts, London, and the Literary and Philosophical Society, Manchester, England; the Royal Irish Academy, Dublin, Ireland; l'Ecole des Mines, Paris, and la Société Industrielle de Mulhouse, France; the K. K. Geologischen Reichsanstalt and the K. K. Geographischen Gessellschaft, Vienna, Austria; the Board of Water Commissioners of Jersey City, New Jersey; and Prof. H. Morton, of Philadelphia.

Mr. J. Vaughan Merrick announced the death of Mr. Thomas Fletcher, when the following preamble and resolution were adopted:

Whereas, The death of Mr. Thomas Fletcher, who was prominent as one of the associates of the founder of the Institute, has occurred since the last meeting of this Board; therefore be it

Resolved, That official notice of the loss thus sustained by the Institute be made at the next meeting thereof, in order that suitable action may be taken.

The various Standing Committees reported their minutes.

The Special Committee on Experiments in Steam Expansion reported progress.

There being no report from the Special Committee on General Totten's letter, relative to the establishment of a Government Bureau of Mechanical Examinations and Experiment, this Committee was by motion, duly carried, directed to report at the next meeting, being subject to discharge according to Article X., Section 3, of the By-laws.

The Special Committee appointed to collect statistics, concerning the history of the Institute, reported progress.

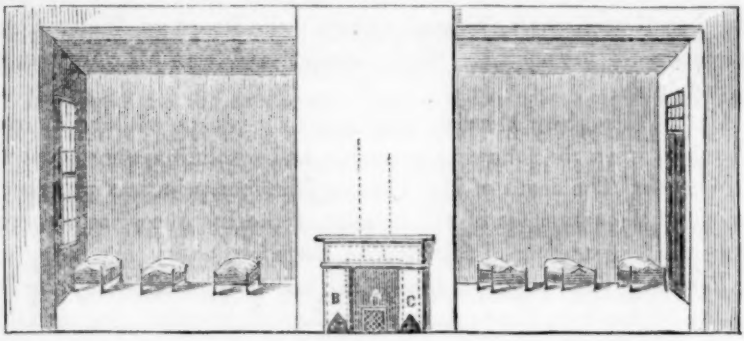
The report of the Resident Secretary on novelties in science and the mechanic arts, was then read as follows:

Secretary's Report.

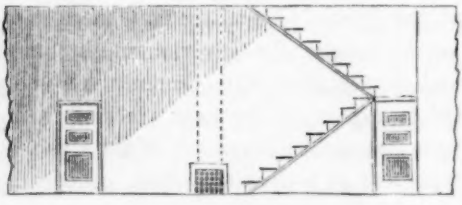
The experiments in warming and ventilating the Philadelphia Almshouse, lately perfected, have met with the most signal success, as we see from the report of Mr. J. M. Whithall, Chairman of the Committee having this matter in charge, (an extract from this report relating to the above, will be found on page 14 of this *Journal.*) We there see, that the ventilation being secured by special flues opening from the *lower part* of the various rooms, and in each case independent, all offensive odor was avoided, the average health of the inmates decidedly improved, and in the case of the cholera and fever, a marked check was given to the spread of the disease, and a speedy recovery effected in those attacked.

The exact arrangement employed, is shown in the accompanying cuts.

The first represents one side of a room, showing the opening for the introduction of hot air at A. The flue by which this comes up, is here abruptly shut off, and the ventilating flues having openings at



B and C, pass up through the sides of the mantle-piece, and uniting above, pass out through the roof by the upper portion of the regular flue or chimney. The second cut shows the plan which has been adopted in the corridors and stairways, where special flues have been constructed. On the occasion of a late visit paid by the Secretary, to the building above named, in company with Messrs. Geo. Erety and L. W. Leeds, the results observed were of the most surprising and satisfactory description. Rooms entirely closed and



occupied by many persons, being, by means of the arrangements above described, kept in a remarkably fresh and inoffensive condition.

The philosophy of this method and its relative efficiency is, we think, easily explained. The warm air driven into the rooms by the heating apparatus is, of course, pure; it equally, of course, rises on entering the apartment, and fills its upper portion. If it is there allowed to escape by a ventilator near the ceiling, it passes out again without having much effect upon the mass of air in the room, which remains stagnant, unchanged, and becomes, by the use of the inmates, very impure. If, however, the only outlet is at the floor, it is the *colder* air which has been longest in the room which goes out, the fresh, warm air gradually taking its place, and thus a regular and complete displacement and circulation is effected, by which means, a warmer temperature is secured with an equal supply of hot air, and the various advantages already enumerated are obtained.

Such a view as above, we think, fairly expresses the actions concerned, without any regard to the effects which are sometimes imagined to result, from the great density of carbonic acid, which, owing to the very dilute condition in which that gas is expired from the lungs, and the rapidity with which it diffuses in the surrounding air, are incapable of producing any practical influence in the present relation. The question, we believe, is not *which part* of the air is taken out, but how to change, in a regular and continuous manner, *the entire mass* of air. Similar results to those mentioned in the above-named report were observed in the case of the New York Poorhouse, on Blackwell's Island, where the cholera, after showing itself with great virulence at first, (some one hundred cases at a time,) was entirely exterpated in five days by a judicious system of ventilation, combined with corresponding treatment, such as exercise in the open air and the like.

Steam cultivation in England.—Mention was made in a previous report, Vol. LII., page 350, of the facts observed in this relation in one part of England, by Mr. Edward Brown, and we now find in *Engineering*, page 379, further statistics and numerous returns from various places, all tending to demonstrate the practical success of these applications. Thus it appears that the average cost of cultivation or plowing, exclusive of interest, repairs &c., is from 3*s.* to 4*s.* 6*d.* per acre. The sources of expenditure above excepted, form however, a heavy item, and when a liberal allowance is made for them, as in the report by Mr. E. L. Betts, with regard to the use of steam on Preston Hall

Farm, Aylesford, the cost of cultivation reaches 10*s.* 3*d.*, and of plowing 14*s.* 4*d.* per acre. Even at this rate, however, the work appears to be economically performed.

Improvements by dredging in the river Tyne have been in progress for many years, and are now in an advanced state. The actual amount of material removed, is about fourteen million of tons, at a cost of about 3½*d.* to 4*d.* per ton, exclusive of machinery, of which enough has been provided to take out four million five hundred thousand tons per year. The sum expended in this work will give some idea of its magnitude. This has already reached over $4,000,000, and it is estimated that nearly $2,000,000 more will be required for its completion. The whole river will then be excavated, so as to yield a depth of fifteen feet at spring low tides.

The Southwark and Vauxhall water-works for London, are distinguished by some peculiarities which may be of interest, and of which we find an account in *Engineering*, page 377. The water from the Thames at Hampton, is admitted into a subsiding reservoir having an average capacity of five million gallons, from which it is pumped by direct-action engines, thirteen miles to Battersea, where it first accumulates in two subsiding reservoirs, from which it passes through filter-beds, and is then pumped into the distributing mains.

The engines at Hampton, pump into a thirty-six inch main against a head of one hundred and thirty-five feet, in a stand-pipe, by which the flow through the thirteen miles is maintained. The filter beds at Battersea are five in number, and have an aggregate area of nine acres. The water enters each of these at the centre, and is collected from a system of branch-drains built of brick with open joints. The capacity of the filter is found to depend very directly upon the extent of these drains, their effect being limited to a narrow lateral area, so that outward flanging-banks add to the cubic capacity but not to the filtering power of these basins. The beds of the filters are lined with concrete, one foot thick; on this is placed the filtering material as follows: Twelve inches of boulders, six inches of coarse gravel, six inches of fine gravel, six inches of hoggin, and then three feet of Hardwhich sand. A head of water averaging four feet is kept upon these. The sand is from time to time, washed in an iron cylinder with a perforated false bottom, through which the water rises from below. During the month of July, the average daily supply of water thus treated was twelve million one hundred and eighty thousand gallons. Five pumping engines are used at Battersea to supply the high level service.

The lake tunnel to supply Chicago with water, is now finished, the actual opening between the two galleries, one from the land, the other from the lake end, having been made in the presence of the Board of Public Works on the 17th of December. This work, from its entirely original and daring character, deserves a thorough record, and we hope before long to obtain full details; in the meantime we may note a few prominent facts.

This structure was designed and executed by E. S. Chesbrough, City Engineer of Chicago. It was begun on March 17th, 1864, and has been steadily advancing ever since. The formation through which it passes, is a stiff clay, containing boulders of porous calcareous stone charged with petroleum, and occasional pockets of sand. One of these caused the engineer above named, a very serious alarm. One morning some of the workmen came before daylight to his house with the news that the water of the lake had burst into the end of the gallery. He hurried to the spot, and descending the shaft, found, to his great relief, no water there. This, of course, showed some mistake on the part of the workmen, and on further examination, it appeared that they had struck a pocket of sand charged with water, which had caved in, and they had escaped for their lives, with such celerity, as not to recognize the true nature of the accident.

In June, 1865, an immense crib, ninety feet in diameter, forty feet deep, intended for the outer end of the tunnel, was towed into its position and lowered, by being filled in with stone in some of its compartments, until it rested on the bottom, two miles from the shore. A cylindrical iron caisson was then forced down in its centre, where an opening had been left for the purpose, and when this had reached the required depth, a gallery was run towards that, which was approaching from the shore.

The above rough outline is chiefly collected from notices in the daily papers, but we hope soon to publish a full account with accurate drawings, from head-quarters.

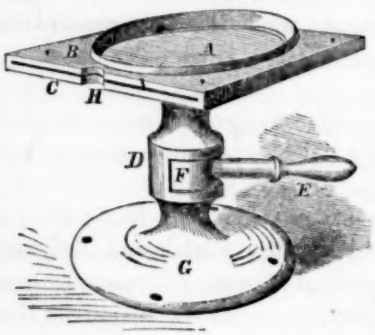
A centrifugal pump of Appold's pattern, was lately tried at the Minotaur graving dock and the steam basin at Portsmouth Dockyard. The indicator diagrams showed an amount of power expressed by three hundred and thirty-three horse-power, while the work actually done by the pump was equal to two hundred and twenty-four horse-power, in the same time. We thus find the efficiency of the pumps to be represented by sixty-seven per cent. of the total indicated force in the engines.

These pumps are coming largely into use, and seem to be both efficient and economical.

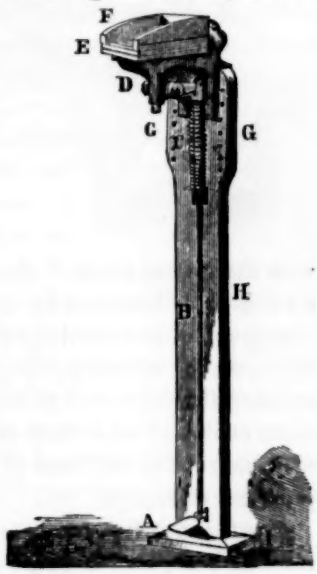
Nitro-glycerine has been used for blasting, extensively, in the stone quarries of the Vosges, near Saverne, by MM. Schmidt and Dietsch. The explosive material is made on the spot, pouring concentrated glycerine into a mixture of one part, by weight, of nitric acid with two parts sulphuric, which has been previously cooled and is kept cool during the operation. The whole material is then poured into cold water, and, after being rinsed and decanted, is ready for use. The little acid and water which the nitro-glycerine retains when thus prepared, would be fatal to its keeping qualities, but is of no account when it is to be used at once. The proper charge of nitro-glycerine being poured into the hole, a little tin case of powder is let down into it by a fuse, and the rest of the hole filled with sand. When the case of powder explodes, its concussion causes the nitro-glycerine to detonate.

In the open quarry no ill effects are found to result from the fumes of this substance, which produce violent headache when inhaled; but in the headings of mines this would be likely to become a serious difficulty.—(See *Journal of the Society of Arts*, page 726.)

The Photograph cutter of Theodore Bergner, was next exhibited and described. The ordinary method of cutting out photograph prints, to an accurate size and shape, by means of a knife and template, is one of the most irksome manipulations connected with professional photography, and of various devices that have been contrived with the object of superseding this slow and imperfect method of cutting, that exhibited to-night by Messrs. Wilson & Hood, is the most ingenious and practically useful one. It is the invention of Theodore Bergner, and has been for some time in use with most of the leading photographers in this city, who have practically tested its durability, and its accurate and expeditious manner of working. It has no knife-edged cutter, but the picture is cut out by a punch and die, producing a keen shearing cut; and a main peculiarity in its construction, consists in the reversion of the ordinary method of applying the punch, which in this case, produces the cut by entering the die from below, thus exposing



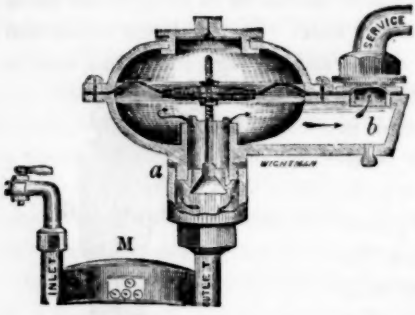
to full unobstructed view, the picture to be cut, so that it can be conveniently and accurately adjusted, before the punch is moved upward to cut it out. The paper is inserted in a shallow space between the die and another similar plate below it, which lower plate is a correct guide for the punch, and also serves to strip from it the paper out of which the picture has been cut. The mechanism for actuating the punch, is not the same in the large instrument as in the smaller ones, but very simple and efficient in either case. In the large cutter the stem carrying the punch extends downward through the stand, and is provided with a coarse screw-thread, fitting a corresponding female thread, in the hub of the hand-lever. The oscillating motion of the lever gives a sufficient vertical movement, and great power to the punch. In the small cutter, the stem of the punch has a notch cut in it, like the space between the teeth of a spur-wheel, and into this notch is fitted a tooth provided on the small transverse rock-shaft. The vibration of this rock-shaft, by means of a rod and treadle, actuates the punch in the required manner. This invention has been recently applied with success, for the cutting out of the large round revenue stamps, which brewers are required to attach to the barrels in which malt liquors are sold, one of the instruments exhibited, being of the kind used for this purpose. These various machines were exhibited, and their operations shown.



An apparatus to indicate the depth of water in a ship's hold, by T. S. Speakman, Esq., was next exhibited. Its structure and action is as follows: A large copper pipe is firmly attached in a vertical position to the kelson, or flooring of the ship. Within this is placed a large cylindrical copper float, water being admitted to the inside of the cylinder from without, by numerous apertures, covered with fine wire gauze, by which means, any sudden change of level in the inside, such as might be produced by the rolling of the vessel, is avoided. From the float a thin metallic rod is carried up to the captain's cabin or other convenient place, and there by a scale, at once indicates the level of water in the hold, at any moment.

An apparatus for the preservation of ship's timbers was also exhibited by the same gentleman as above. This result is reached, by circulating fresh sea-water around the kelson, and thus, from time to time, rinsing out the bilge-water.

The Leffingwell gas regulator was next exhibited. This instrument consists of a circular iron vessel, divided across the middle by an elastic horizontal diaphragm, and having in its lower part two passages, an inlet, *a*, and an outlet, *b*. The inlet is connected directly with the gas-meter, M, and the outlet with the service-pipes. The flow of the gas in inlet, *a*, is controlled by a conical valve whose stem is supported by the diaphragm, and which thus varies in position with the rise and fall of that part. Thus, when the pressure in the service-pipes increases by the sudden shutting off of burners, the diaphragm rises and partially closes the valve, so as to cut off the supply; when, on the contrary, the pressure decreases, the diaphragm falls, so opening the valve and giving a freer passage to the gas. The advantages claimed in this form of instrument over others, are its cheapness of construction and ease of management, while it yields to none in practical efficiency.



Small working models of locomotives and other steam engines, from J. W. Queen & Co., were then exhibited in action. Their peculiarity consists in great simplicity of structure, by reason of which, they could be made at so cheap a rate as to become toys, while, at the same time, their working was most efficient, (a little locomotive with its tender, ran across the laboratory table, twenty feet long, so rapidly as to need quick following to save it from a fall at the end.)

Spectrum analysis of stars, by Father Secchi.—This author, in a paper read before the French Academy, divides the stars, as regards their spectra, into three classes: 1. White stars, showing a strong band in the green-blue, (Franenhoffer's line F.) Another, a little in the violet a little short of G. About one-half the stars are of this type. A few exceptions, however, occur thus, ζ Cassiopeiae, and β Lyrae, though white stars like the rest, show bright lines in place of these dark ones, while all the stars of Orion, except (α) show very fine bands

in the place of these heavy ones. These stars of Orion, are in fact, unique; none others in that portion of the heavens, are found like them. 2. Redish stars with bright bands in the red and orange. Examples of this class are found in α Orionis, α Tauri Antaris, β Pegasi, α Herculis &c. In the last of these, the spectrum looks like a row of colored columns illuminated from one side. 3. White stars, with many fine lines, corresponding to those found in the sun, which in fact belongs to this class, together with Arcturus, Capella, Pollux &c.

The solar line B is due to carbonic acid, according to Angstrom, who found that it remained with undiminished intensity at Upsal, with a temperature of 16·0° F., when the aqueous lines generally were obliterated.

The relations between the wave lengths of absorption bands in the spectra of elements, have been elaborately studied by Gustave Hinrichs, and made the subject of a voluminous paper in *Silliman's Journal*, (Nov. 1866, page 350.) Some of his most interesting conclusions are the following: That the wave lengths corresponding to the bands in each elementary spectrum, differ, by a fixed number or some simple multiple of the same, or, in other words, that if we suppose lines to have been made at regular intervals, and then some of them obliterated, the actual condition now existing would be reproduced.

That the dark lines are produced by a certain interference.

That they are the result of, at most, three systems of interference.

That the lines generally are closer, the greater the atomic weights of the elements.

That the distance of the lines is also related to the atomic dimensions.

The character of electric discharge in rarified gas, and the cause of stratification in the light so produced, has been made the subject of an interesting publication by De la Rive. His conclusion is, that the stratification is due, like the sonorous wave, to a regularly recurring variation, in a series of vibratory impulses, by which lines or surfaces of various density are established in the rarified medium. The electric discharge meeting with more resistance in the denser parts, there develops more light. He also shows that the dark spaces become less heated. For further particulars, see *Chemical News*, page 190.

An ice machine on Carré's plan is said to be in very successful operation at Schreveport, Louisiana, making eight thousand pounds per day, and yielding a large profit to those working it.

A process of inverse filtration, by M. Carey Lea, of this city, is described in *Silliman's Journal*, page 380, and promises to be very useful in certain cases. A piece of muslin, with or without filter paper inside, is secured over a glass funnel, and the latter is then inverted in the vessel of liquid to be filtered, an india rubber and a glass tube being attached to the stem of the funnel, so as to convert the whole into a syphon, which being filled with water, will draw the liquid through the muslin &c., thus filtering with considerable rapidity if desired.

Sulphate of barium as a substitute for white-lead is now largely used for the glazing on paper collars. Twenty tons (?) per day are said to be so used in New York.

A recipe for blue ink, by M. Vogel, is given in the *Chemical News*, page 166, in effect as follows: Dissolve one hundred and fifty grains of green vitriol ($TeOSO_3$) in a large quantity of water, boil and oxidize by nitric acid. To this solution add another, containing one hundred and fifty grains of yellow prussiate of potash (KCfy), by which, of course, prussian blue is precipitated; this precipitate after subsiding, decanting, filtering and washing, is mixed in a mortar with thirty grains of oxalic acid, and after standing for an hour, about half a pint of water is added.

The fibres of the cotton plant have been successfully manufactured into cloth at New Orleans, as it is stated.

An immense deposit of pure rock-salt has been found at Pahranagat, in Nevada, the mineral being in many cases of perfect transparency.

The English practice in construction of blast furnaces, seems to be going in the direction of increased size and a higher temperature. Dimensions of twenty-five feet at the boshes and eighty feet in height, and temperatures of one thousand and fifty degrees and eleven hundred degrees, are employed, with marked economy and no drawback from the crushing of the charge and "gobbing" of the furnace, (*i. e.*, choking with dense mass of material impervious to the blast.)

The Rosedale and Ferry-hill Company are even about to blow-in a pair of furnaces, twenty-seven feet in the boshes and one hundred and two feet high. The result of these changes has been to reduce the consumption of fuel to so little as twenty-one hundred weight for each ton of pigs, made from an argellaceous stone containing thirty-one per cent. of iron. For further particulars on this subject, see *Engineering*, page 400.

Deferred business being then in order, it was moved, in accordance

with a resolution carried at the previous meeting, that a committee be appointed by the President, to draw up a memorial to Congress relative to the establishment of an uniform code of danger signals, throughout the United States. This motion was duly seconded and carried.

New business being next considered, the following preamble and resolutions were offered by Frederick Fraley, Esq., and adopted by the Institute.

Whereas, Thomas Fletcher, one of the associates of the founder of the Franklin Institute in bringing it into organized and useful existence, departed this life on the 14th day of November, A.D., 1866, after a long and useful career; therefore, for the perpetuation of the memory of such a man, it is

Resolved, That we shall ever cherish in our grateful remembrance, his services as Treasurer and Vice-President, and the hearty zeal which, during his active membership, he manifested for every measure that would promote the usefulness and prosperity of the Institute.

Resolved, That while we sympathize with his family in their bereavement, we feel assured, that as he had filled the characters of parent, friend and citizen, for a period rarely allotted to man, in a way honorable to himself, their grief will be solaced by the many memories of his work.

Resolved, That the Secretary transmit a copy of these proceedings to the family of Mr. Fletcher.

A letter from Prof. John F. Frazer, resigning his office as Vice-President of the Institute, was read by the Secretary, and, on motion of Frederick Fraley, Esq., it was

Resolved, That the Institute receives with regret the resignation of Prof. Frazer, and that its members desire to express their sorrow that ill-health should withdraw him from those duties and services, for whose performance in past time they wish to tender their sincere thanks.

Resolved, That the Secretary be directed to communicate to Prof. Frazer the above resolution.

On motion of Coleman Sellers, Esq., the meeting then went into nomination of officers and managers for the ensuing year, when the following nominations were made:

For President, J. V. Merrick.

For Vice-Presidents, George Erety, Coleman Sellers, and Robert Briggs.

For Resident Secretary, Prof. Henry Morton.

For Treasurer, Frederick Fraley.

For the Board of Managers, George Erety, William J. Horstmann, Henry Cartwright, Samuel Hart, B. H. Moore, H. G. Morris, William B. Bement, E. Y. Townsend, William Sellers, Robert Briggs, Prof. Robert E. Rogers, James Moore, G. S. Rosengarten, J. Harrison, William P. Wilstach, Edward Longstreth, R. A. Tighlman, Barton H. Jenks, Robert H. Long, Alexander Irvine.

For Auditor, J. H. Cresson and Mordecai Haines.

The President then appointed as Judges of Election, William A. Rolin, Henry Aimes, Clarence S. Bement, Mordecai W. Haines, C. Eugene Meyer, Hector Orr and John L. Perkins.

The meeting was then, on motion, adjourned.

HENRY MORTON, Secretary.

Bibliographical Notice.

PHOTOGRAPHIC MOSAICS; An Annual Record of Photographic Progress. Edited by M. C. Lea, M.D., and E. L. Wilson, Editor of *Philadelphia Photographer*.

WE have received from Messrs. Bennerman & Wilson the above work. Its neat binding and clean typography are *prima facie* evidences of its worth. A fuller examination of its contents will add to the conviction that it is a valuable contribution to the Photographic art. It is, indeed, a Photographer's *vade mecum*, full of valuable receipts and practical suggestions for securing excellence and avoiding defects in photographic work, with wise lessons of economy and judicious advice to landscape and portrait experimenters.

Photography is now becoming so widely popular and so very important an art in many branches of science and industry, that any contributions which help to advance its certainty, economy and scope, are to be hailed with satisfaction. Messrs. Bennerman & Wilson, by the publication of their *Philadelphia Photographer*, have done a great and good work in this direction. Their monthly magazine is in advance of any other publication with which we are acquainted on either side of the water, and, so far as we know, is the only publication in the cause of Photography on this.

We wish, as we anticipate, all success to the new work now before us, *Photographic Mosaics*.

A COMPARISON *of some of the Meteorological Phenomena of* NOVEMBER, 1866, *with those of* NOVEMBER, 1865, *and of the same month for* SIXTEEN *years, at Philadelphia, Pa.* Barometer 60 feet above mean tide in the Delaware River. Latitude 39° 57½′ N.; Longitude 75° 11¼′ W. from Greenwich. By PROF. J. A. KIRKPATRICK, of the Central High School.

	November, 1866.	November, 1865.	November, for 16 years.
Thermometer—Highest—degree	70·00	66·00	80·00
" date	29th.	17th.	1st, '60.
Warmest day—mean	64·50	62·33	72·30
" " date	29th.	17th.	9th, '57.
Lowest—degree	29·00	26·00	16·00
" date	26th.	11th.	25th, '60.
Coldest day—mean	35·83	33·00	23·30
" " date	24th.	11th.	25th, '60.
Mean daily oscillation	13·63	11·63	13·19
" " range	5·85	4·73	5·66
Means at 7 A. M.	42·95	41·43	41·31
" 2 P. M.	52·33	49·63	50·38
" 9 P. M.	46·93	44·45	44 57
" for the month	47·40	45·17	45·42
Barometer—Highest—inches	30·358	30·405	30·661
" date	5th.	10th.	12th, '51.
Greatest mean daily pressure	30·327	30·387	30·520
" " " date	5th.	11th.	12th, '51.
Lowest—inches	29·327	29·395	29·080
" date	16th.	22d.	4th, '64.
Least mean daily pressure	29·382	29·443	29·150
" " " date	16th.	22d.	4th, '64.
Mean daily range	0·157	0·156	0·182
Means at 7 A. M	29·913	29·901	29·909
" 2 P. M	29·858	29·837	29·861
" 9 P. M	29·891	29·877	29·896
" for the month	29·887	29·872	29·889
Force of Vapor—Greatest—inches	0·513	0·534	0·832
" date	29th.	17th.	8th, '57.
Least—inches	·060	·094	·055
" date	25th.	28th.	25th, '57.
Means at 7 A. M	·218	·201	·223
" 2 P. M	·213	·218	·228
" 9 P. M	·242	·217	·232
" for the month	·224	·212	·228
Relative Humidity—Greatest—per cent	89·0	96·0	100·0
" date	11th & 26th.	21st.	Often.
Least—per cent	25·0	33·0	25·0
" date	25th.	13th.	7, '63 & 25, '66
Means at 7 A. M	74·6	74·6	77·0
" 2 P. M	51·0	58·7	58·5
" 9 P. M	71·0	70·2	73·1
" for the month	65·5	67·8	69·5
Clouds—Number of clear days*	10·	12·	8·6
" cloudy days	20·	18·	21·4
Means of sky covered at 7 A. M	56·7 per ct	57·7 per ct	60·3 per ct
" " " 2 P. M	56·7	55·0	60·3
" " " 9 P. M	49·0	39·3	51·9
" " for the month	54·1	50·7	57·5
Rain—Amount—inches	1·474	3·598	3·623
No. of days on which rain fell	7·	6·	10·3
Prevailing Winds—Times in 1000	s 84°17′ w·251	s 51°46′ w·255	s 72°53′ w·257

* Sky one-third or less covered at the hours of observation.